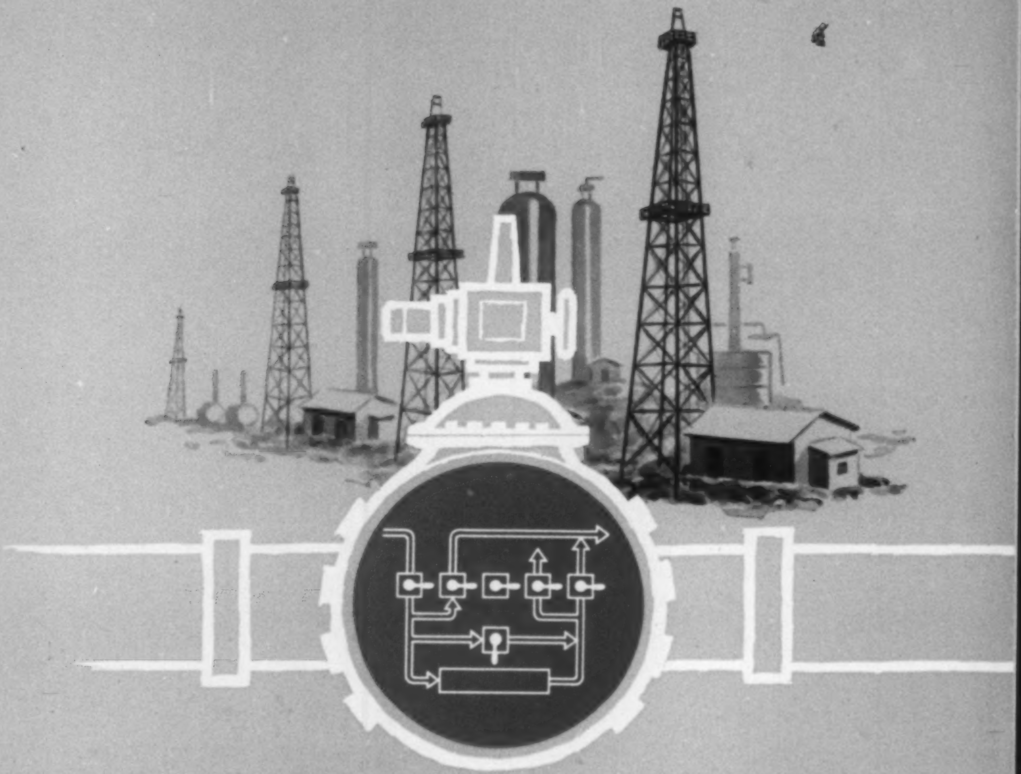
AUTOMATION

AUGUST 1958



AUTOMATIC TECHNIQUES OF

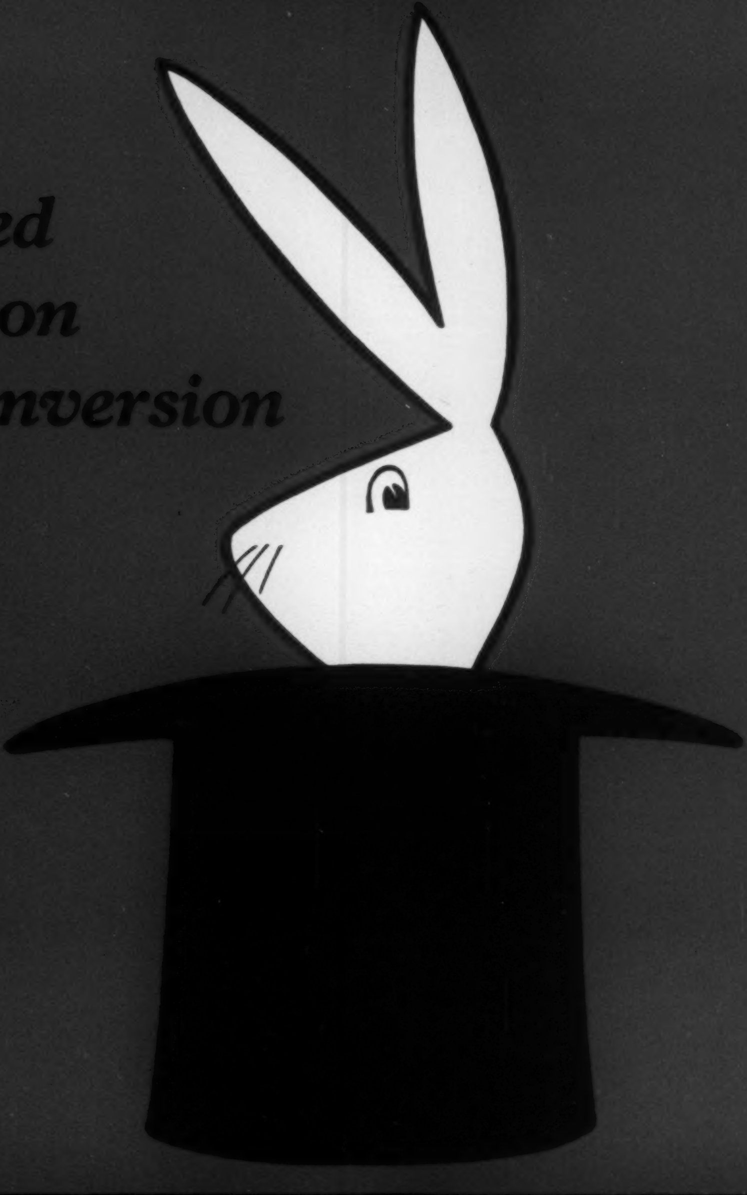
Oil and Gas Production

The Magazine of Automatic Operations

- **Manufacturing Team for Automation**
- **Automatic Mold Production**
- **Numerical Positioning Control**
- **Infrared Radiant Heating**

CONTENTS — PAGE 3

A PENTON PUBLICATION



Segmented automation makes conversion practical

Circle 651 on Page 131

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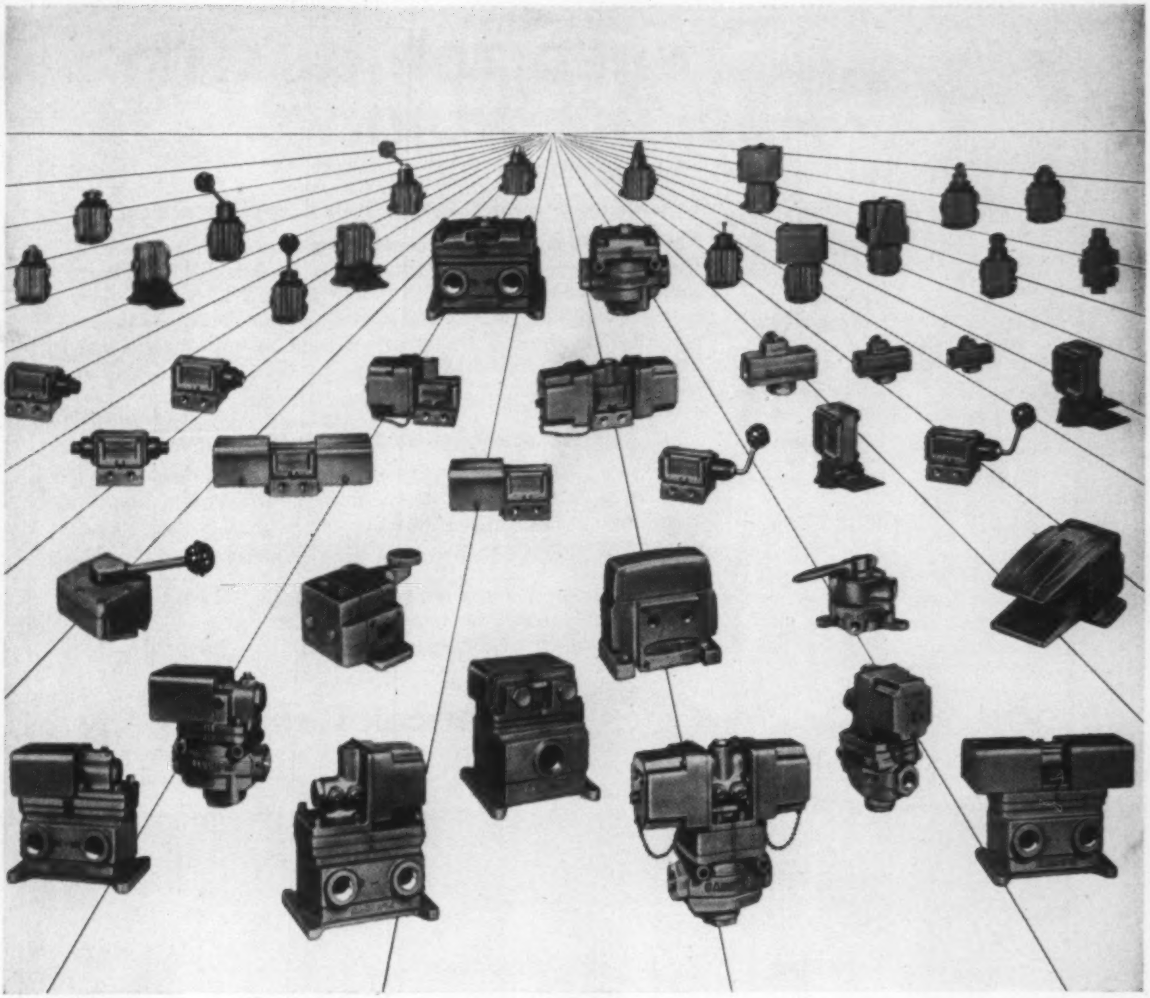

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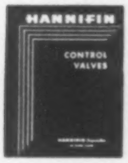
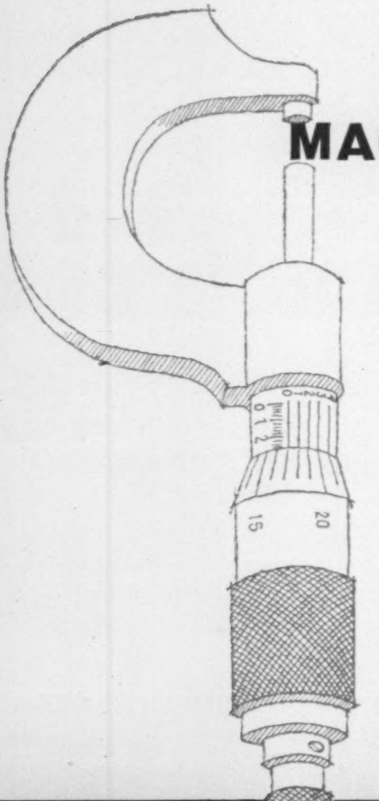


For this complete catalog showing all the Hannifin directional air control valves, write to Hannifin Company, 541 South Wolf Road, Des Plaines, Illinois. (Hannifin Company is a division of Parker-Hannifin Corporation.)

Circle 654 on Page 131



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AUGUST 1958
Vol. 5 — No. 8

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Operations

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Directly Co-ordinated, 33
EDITORIAL—divided responsibility for design and production engineering must be eliminated if optimum plant operation is to be achieved.

Manufacturing Team for Automation, 34
D. J. YOMINE—discusses means of obtaining necessary teamwork by engineering and production for successful product development.

Automatic Mold Production, 38
AUTOMATION TODAY—operating experience in automotive installation proves feasibility of highly mechanized foundry.

Pharmaceutical Packager, 42
SIDNEY E. HARRIS—special production requirements are satisfied by in-plant development of machine to fill and cap glass vials.

Numerical Positioning Control, 45
DRILL PRESS—installations of point-to-point positioning control emphasize advantages of the system for job-lot operations.

Carbon Brick Manufacture, 48
SPECIAL PRESS—shapes carbon products as electrical current passes through and heats carbon mixture in an improved process.

Infrared Radiant Heating, 49
PAUL H. KRUPP—review of equipment characteristics prepares the way for wider application of an important production technique.

Photocell Length Detector, 55
BINDER OPERATION—utilizes unique gaging means placed in production line to sense and reject unsatisfactory work.

Oil and Gas Production, 57
NEWTON E. ARMSTRONG—summarizes petroleum industry techniques for achieving more efficient operations of oil fields and pipelines.

Automatic Balance Checking, 62
MISSILE PRODUCTION—locating missile's center of gravity is greatly simplified by equipment using strain gages as sensing devices.

Automation in Action, 64
PICTORIAL PRESENTATION—drilling unit; heat treat control; painting fixture; thickness gage; and plastics production.

Automatic Painting Equipment, 66
ERIC H. COCKS—explains how to evaluate pertinent factors influencing acquisition of a spray painting system.

Broke Handling System, 70
REPULPING UNIT—salvage from paper mill operation is automatically mixed with water to obtain pulp of desired consistency.

Servo Systems, 71
R. HADEKEL—part seven—conclusion of series on the synthesis of systems for hydraulic control of automatic machinery.

REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Meetings and Events, 23
Detroit Dateline, 25
Western Roundup, 28
New Equipment, 79
New Components, 95
Abstracts, 115
Books, 122
Patents, 123
Editorial Index, 124
Problem Forum, 126
Advertising Index, 127
New Literature, 129
Equipment Index, 131
Readers' Reply Card, 131

automation outlook

ORGANIZATION FOSTERS TEAMWORK

". . . to find the ways and means to satisfy the ever-growing demand of the consumer for higher product quality and lower price, industry must use every bit of its manufacturing creativeness. Progressive management must place an increasing emphasis on the organization structure that will best encourage this creativeness. It will be progressive management that will emphasize interdepartment understanding, encourage a spirit of teamwork, and emphasize the need for fulfilling over-all marketing objectives. Interdivision understanding will also help greatly in attaining the over-all objectives, which of necessity include full utilization of the many advantages available through application of automation techniques in manufacturing operations . . ."—*D. J. Yomine, mgr., Production Engineering, Bell & Howell Co., see page 34.*

PRACTICAL AUTOMATION DEFINED

". . . practical industrial automation can be said to be manufacturing, processing, or performing of services automatically to the degree indicated by the economics at the time. This is the type of automation which can actually make things available to a user at a price he can pay . . ."—*Lee D. Miller, associate editor,* AUTOMATION, *see page 115.*

FERTILE FIELD

". . . automation in passenger accounting has great potential when you envision a continuity of the automation principle from ticketing to financial settlement between carriers. This is a reality in other fields of activity and is now overdue in passenger accounting. Where there are routine operations and repetitive volumes there is a fertile field for automation . . . "—*B. A. Corkran, auditor, Passenger Accounts, Chesapeake & Ohio Railway Co.*

A NEIGHBOR'S VIEW

". . . over the next decade, automation is certain to become a reality in large Canadian businesses . . . Far from being something to be feared, automation will make work more pleasant and profitable and will emphasize the responsibility of the individual. In all, properly integrated automation should mean the opening of new horizons for both industry and labor . . ."—*F. P. Thomas, director of data processing, Hydro Electric Power Commission of Ontario, Toronto, Canada.*

THOUGHT PROVOKER

". . . fifty cents of every dollar spent at the retail level represents costs of distribution—carrying raw materials to the manufacturer and the finished product to the wholesaler, the retailer, and ultimately to the doorstep of the consumer. The consumers' demands that the line be held on prices dictate greater economy in all distribution channels . . ."—*Charles F. Venrick, vice president, American Car & Foundry Div., ACF Industries Inc.*

SIGN OF THE TIMES

". . . several years ago a group of expert metrologists from the machine tool industry notified the National Bureau of Standards that the accuracy of existing master gage blocks was no longer sufficient to meet their most advanced needs. They urged a program to develop superior gage blocks and associated measurement techniques so that their dimensions could be reliably certified to one or two ten-millionths of an inch . . ."—*A. V. Astin, director, National Bureau of Standards.*

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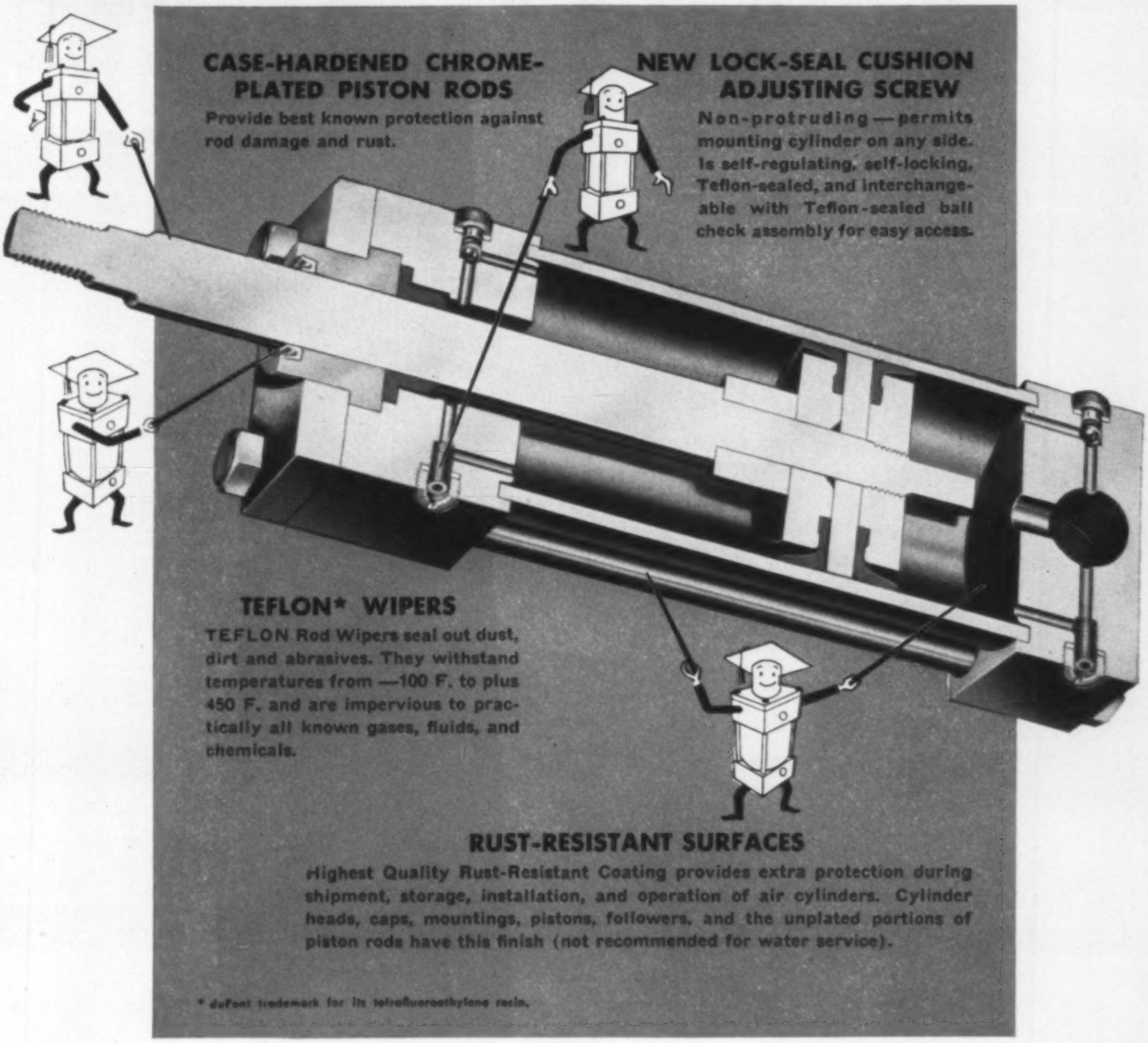

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* duPont trademark for its tetrafluoroethylene resin.

Other Standard Miller Quality Features include: bar stock steel heads, caps, and mountings; rust-resistant brass barrels; self-regulating, wear-compensating piston rod seals that never require adjustment; space-saving square design; and other features as shown in Bulletin A-105 sent free on request.

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Circle 656 on Page 131

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DIVISION OF FLICK-REEDY CORPORATION

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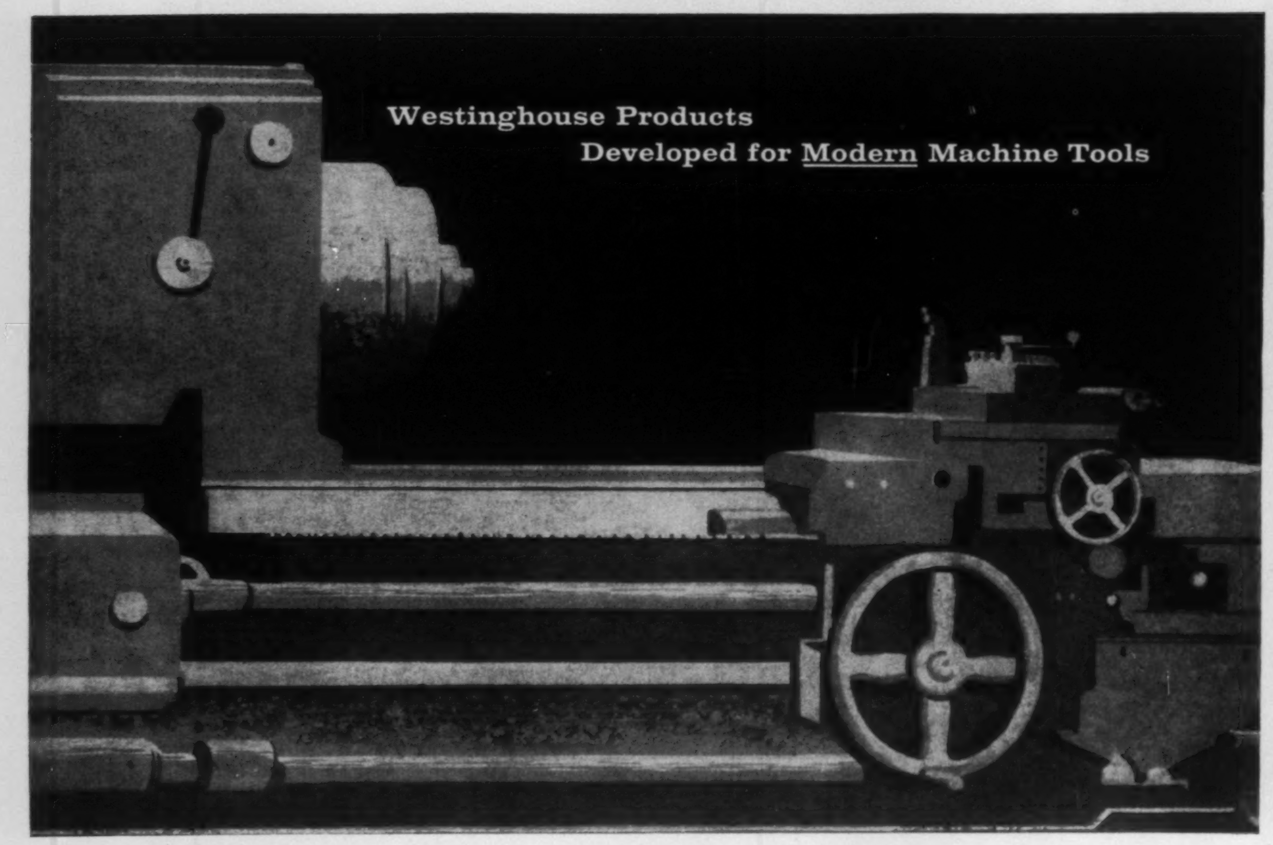
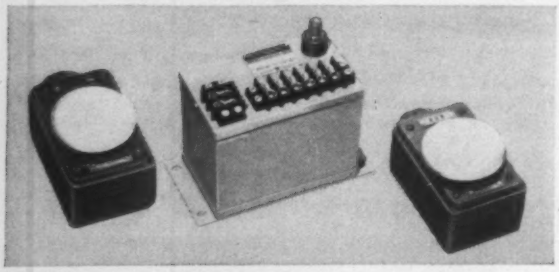
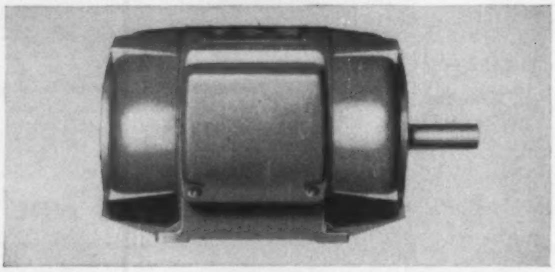

Westinghouse Products
Developed for Modern Machine Tools



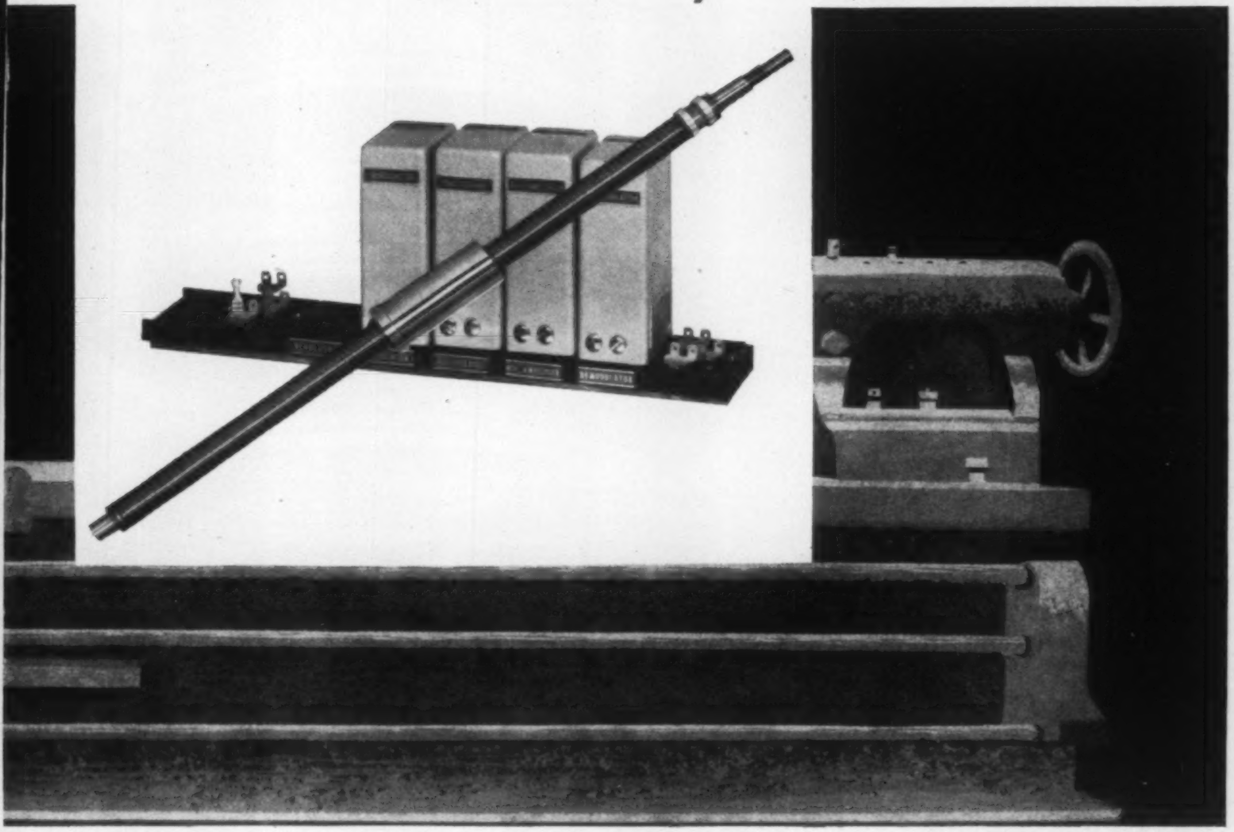
New Westinghouse Cypak® Dual Safety Interlock is a highly reliable, anti-repeat safety device for punch press operation—completely static; no moving parts, contacts or tubes to wear or burn out.



Westinghouse Life-Line® "*A*" a-c motor, the industry standard, combines Bondar®, Bondite and Mylar* insulation for long life. Prelubricated, factory sealed bearings eliminate need for lubrication—keep lubricants in, dirt out.

*Du Pont registered trademark

WESTINGHOUSE CONTROL 1 PART IN 100,000



Unaffected by wear and free from backlash, NULTRAX linear positioning system makes possible the measurement of linear displacement on one or more axes to accuracies of one hundred thousandth of its full range of travel, which may extend over distances of many feet. NULTRAX and other Westinghouse numerical control systems are available to cover the complete range of production accuracies.

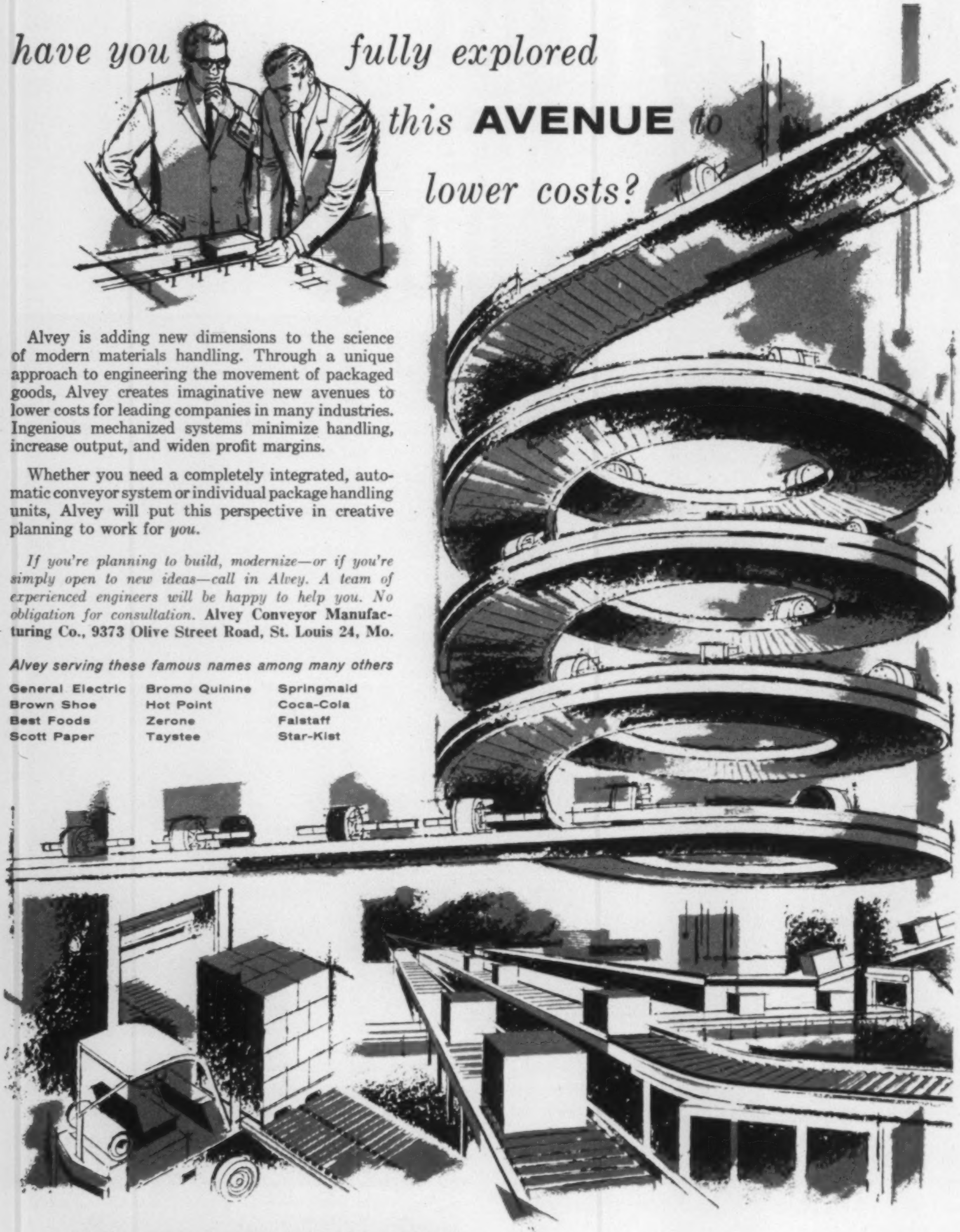
Positioning systems are another example of Westinghouse products—the sign of a modern machine tool designed to give the most production at the lowest possible cost. A coordinated electrical system, designed and supplied by Westinghouse industry-experienced engineers, is sure to give the best in long-term economical service.

For complete information about NULTRAX and other Westinghouse POWER-UP products for modern machine tools, ask your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-96112

YOU CAN BE SURE ... IF IT'S

Westinghouse

Circle 657 on Page 131



Alvey is adding new dimensions to the science of modern materials handling. Through a unique approach to engineering the movement of packaged goods, Alvey creates imaginative new avenues to lower costs for leading companies in many industries. Ingenious mechanized systems minimize handling, increase output, and widen profit margins.

Whether you need a completely integrated, automatic conveyor system or individual package handling units, Alvey will put this perspective in creative planning to work for *you*.

If you're planning to build, modernize—or if you're simply open to new ideas—call in Alvey. A team of experienced engineers will be happy to help you. No obligation for consultation. **Alvey Conveyor Manufacturing Co., 9373 Olive Street Road, St. Louis 24, Mo.**

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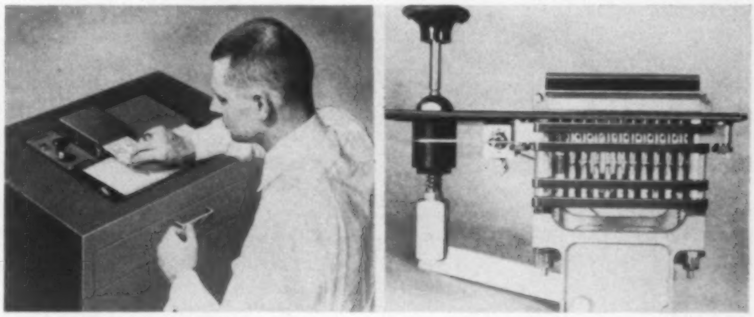
Circle 658 on Page 131

AUTOMATION news

Today's events and developments in the field of automation

Automatic Multiple Switch Programmed By Punched Card

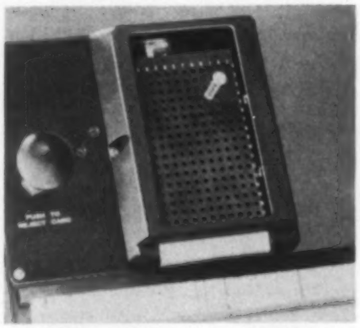


PREPUNCHED card is inserted into switch to select contact pattern. Switch deck is made up of 187 single pole, single-throw floating contacts in a sandwich design that allows individual connection to all contacts on the bottom plate of the switch. Button and lever arrangement opens all contacts and releases code card.

MULTIPLE switching is a practical method for handling complex data in programming, automatic inspection, computer work, and similar operations. Hickok Electrical Instrument Co. has developed a reliable and flexible switch design that can be programmed by punched card to provide a choice of contact actuations from literally millions of switching combinations (switch has 187 single pole, single-throw floating contacts in a 17 x 11 matrix). The circuit rating of the switch is 10 amperes; contact-to-pin-to-contact resistance rating is 0.0005 ohms nominal.

Inserting the code card into the unit operates a momentary control solenoid trip mechanism that actuates all desired contacts simultaneously. Design of the card is such that it must be placed in the switch in proper orientation or the trip mechanism will not function.

Individual contacts of the switch are actuated only if their representative hole locations have not been punched. This design scheme provides a built-in safety feature since no contact will make if the switch is accidentally actuated when a card is not in reading position. The presence of a hole over open contacts also allows an operator to augment the programmed switching pattern by inserting a suitable nonconductor punch into a desired hole to actuate a given contact.



ABSENCE of hole in card actuates individual contacts. Hole over open contact permits manual operation of individual contacts by insertion of nonconducting punch.

Construction of switch, in which 187 male contacts are sandwiched between upper and lower plates containing female contacts, provides for flexible wiring arrangements. Lower plate contains 187 female contacts, all accessible for individual connection. Upper plate contains an additional 60 contacts that invite simplification of wiring through the use of terminal strip connections.

Vulcanized Punched Tape

EXTREMELY thin, high-strength vulcanized fibre tape, designed for use on punched tape controlled automatic programming equipment, has been developed by National Vulcanized Fibre Co. This special cellulose plastic tape has a tensile strength of better than 6000 psi, high density, low porosity, excellent abrasion resistance — and is easily punched. The tape is designed for applications requiring an economical tape with a relatively long useful life. It falls between paper and polyester film in cost and wearing properties. It has an estimated maximum life of 1 million cycles.

Quarterly Economic Reports Show Business On Upturn

REVIEW of current economic conditions prepared by Guaranty Trust Co. of New York suggests that the second quarter of 1958 will go down in the annals as the low point of the current business cycle. The record for the period is still not complete, but what is known is decidedly favorable on balance, in the sense that a definite transition from decline to stability is recognizable.

For manufacturers, the second

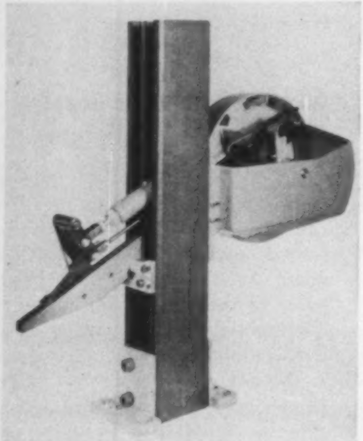
quarter witnessed a cessation of the fall in new orders and considerable further progress toward inventory balance. One tangible result of this improvement was the upturn in May and June in the index of industrial production, after eight consecutive months of decline. It also apparently reduced to mere attrition the previous sharp reduction in factory employment.

What is perhaps more important and more gratifying than anything else is that the really critical phase of the business adjustment appears to be in the past rather than the future. Actually, this most critical phase probably occurred fairly early in the year when business statistics were very bleak and when there were few indications that a bottom might be close at hand. The danger then was that general sentiment might be undermined and that concern would give way to alarm.

The record of the second quarter strongly suggests, however, that such danger has now been averted. Sentiment did not deteriorate when the statistics were worst but instead firmed up, and the improvement was sufficient to affect market transactions in key areas in a positive way. Since sentiment managed to withstand the barrage of bad business news early in the year, the danger of deterioration now would not seem very great, inasmuch as business statistics have meanwhile improved.

While most recent developments have been of an encouraging nature, there is one major exception, namely, the trend of capital spending. The latest quarterly survey of investment intentions conducted by the government not only confirms the probability of continuing decline in this sector throughout 1958 but indicates as well that businessmen have been scaling down programs since the previous survey was taken. Businessmen now expect to spend a total of $30.8 billion on capital projects this year, 17 per cent less than the record outlays in 1957. In the survey reported a quarter earlier the anticipated decline from 1957 was 13 per cent.

This is a substantial setback and, if actually realized, will be the most severe of the postwar period. It means that recovery forces, if they are to make early progress, will have a significant drag to overcome. It is primarily because of this outlook for capital spending that so many observers lean to the view that recovery will be relatively slow in its early phase. Indeed, some analysts think that the decline in capital spending will prevent near-term recovery and believe instead that the economy may experience a "long bottom." This, however, may be too extreme a view, particularly since vigorous recovery got under way after the 1954 recession before the decline in capital spending was arrested.



COMPACT, combination parts feeder and escapement unit, designed for placing a broad range of small parts automatically, has been developed by Dixon Automatic Tool Inc. The new unit, sold either with or without tooling, includes feeder, feed track, escapement mechanism, and a new twin-rail mounting column. Parts are controlled and fed by the action of a single dual-purpose air cylinder, connected on one end to a positive-acting escapement mechanism, and on the other end to a feeder drum operating arm which provides intermittent rotation of the vertically mounted feeder drum. Nine integral lugs cast on the inside of the rotating drum deliver the piece-parts to a metal loading tray that can be easily cut or shaped to properly guide piece-parts into machined grooves of the feed track. A spring-steel finger, attached to the upper end of the operating rod, automatically discards mis-oriented parts. The design permits easy adjustment to suit feed and speed requirements.

CAPABLE of reaching controlled temperatures of 3000 F and higher, new C. I. Hayes Inc. high temperature/high vacuum production furnace has performance characteristics formerly found only in laboratory equipment. Temperature control to within a few degrees accuracy is possible with saturable reactor type power control that responds to direct scanning of electrical heating element. Heating elements can be interchanged easily to vary general operating range of the furnace. Desired temperature can be reached within 30 minutes after pumpdown and special cooling chamber atop furnace allows charges to cool to below 700 F within an equal period of time.

Control System Reduces Water Processing Costs

INSTALLATION of a control system for converting a water processing pumping station from manual to automatic remote operation has enabled the Celanese Corp. of America to save an estimated $14,700 in water processing costs over a one year period. The equipment for the supervisory system was supplied by the Medium Voltage Switchgear Dept., General Electric Co.

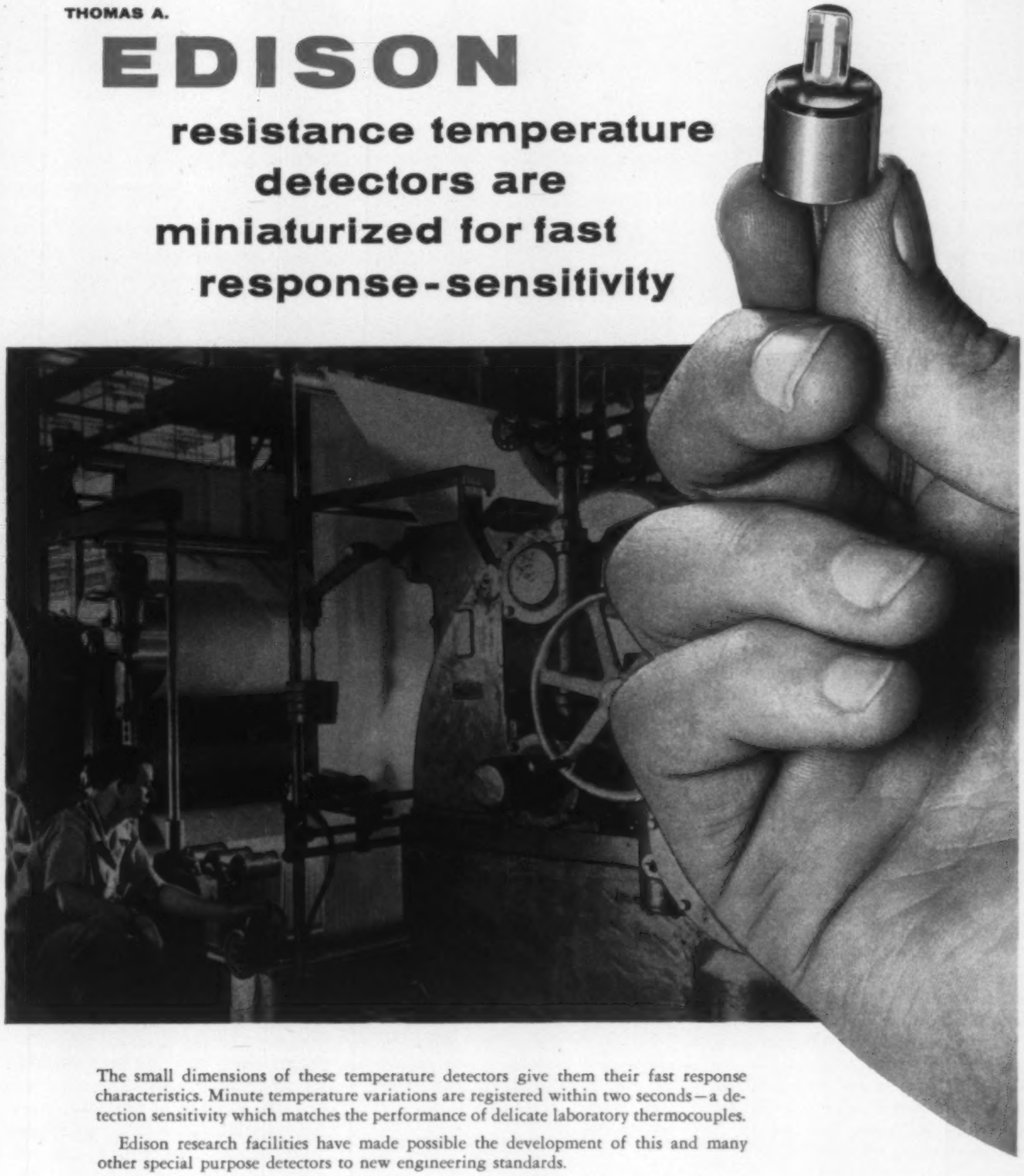
The Celanese plant near Rock Hill, S. C., manufactures cellulose acetate and acetate yarn and requires a water system of 50,000 gpm capacity for process cooling, boiler-feed makeup, drinking, and sanitary purposes. The control system starts and stops pump motors as dictated by the water level in a nearby reservoir. In addition, traveling screens in the river pump intakes were automated by incorporating them into the control system.

The control system consists of a master panel located at the plant's booster pumping station, and a remote panel located near the river pumps approximately one-half mile away. Two telephone wires connect the master and remote stations to operate five river pumps. By

THOMAS A.

EDISON

resistance temperature detectors are miniaturized for fast response-sensitivity



The small dimensions of these temperature detectors give them their fast response characteristics. Minute temperature variations are registered within two seconds—a detection sensitivity which matches the performance of delicate laboratory thermocouples.

Edison research facilities have made possible the development of this and many other special purpose detectors to new engineering standards.

Designed to measure oil film temperatures, these units have been miniaturized to the point where they can be positioned in direct contact with bearing oil film in a wide variety of applications.

For complete information on Edison Resistance Temperature Detectors, write for Bulletin No. 3016.

Thomas A. Edison Industries
INSTRUMENT DIVISION
86 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

SEE US AT THE
ISA SHOW BOOTHS
1426-1527

Circle 659 on Page 131

converting the pumps from manual to automatic operation, maintenance and operator time has been reduced to one inspection tour per shift.

Static Control Seminar Hits the Road

STATIC control of automatic production equipment and processes through use of saturable core magnetic switching reactors was the subject of an invitational seminar recently held in Cleveland by Control Div., Magnetics Inc. **Edgar V. Wier**, principal speaker, is a consultant and board member of Control Division.

Engineers and technical management people concerned with the design and use of static controls were present in two half-day sessions. Idea behind the seminar was to dispel through education some of the prevalent misconceptions about static controls in relation to their cost, versatility of application, and complexity. Translation of input signals into logic functions to accomplish switching of ac or dc loads was discussed for a variety of industrial applications.

The seminar held in Cleveland was the first in a program which calls for the holding of similar meetings in other cities.

Special Designs Emphasize Electronic Tube Versatility

OVER 100,000 pieces of information may be stored in a special tube developed by Westinghouse Electric Corp.'s electronic tube division. The tube was developed primarily for defense purposes, being designed to store information generated by radar receiver apparatus.

The tube contains three electron guns: One gun receives and writes information on the memory unit; a second gun erases stored information; and a third gun enables stored information to be displayed on a fluorescent screen long enough for a human observer to read. Possible commercial use of the tube is anticipated in view of the increasing em-

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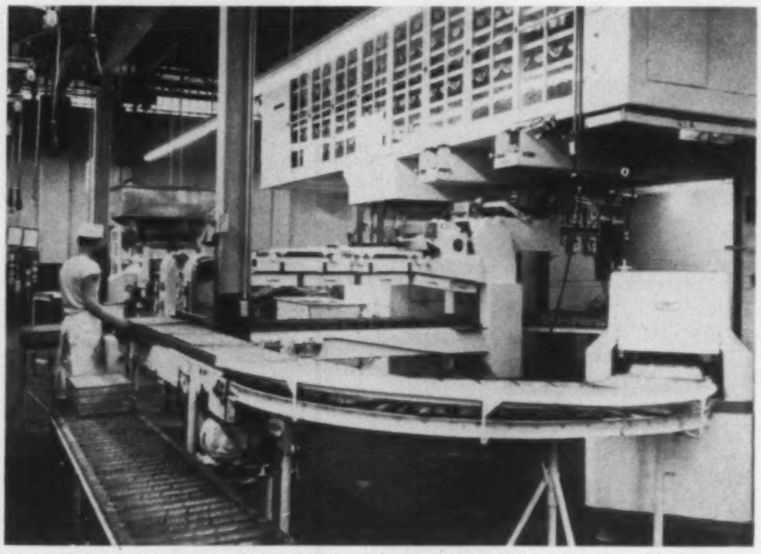
Lost Art of Bread Twisting Revived By Automated Line



TWISTED bread went out the window with a government edict during World War II and except in certain sections of the country, twisted bread never came back. The reason: High bakery production costs. Today, the picture is changing. A molder-twister-panner has been developed by the Food Machinery Div., Baker Perkins Inc. Bread twisting can now be fully automatic with a machine that mechanically duplicates hand twisting and the results of hand twisting—fine texture of the product, softness, better taste, and loaves that stay fresh longer.

The machine handles up to 2-pound loaves of bread at a maximum rate of 45 twisted loaves per minute. In other words, it processes 90 individual dough pieces per minute to the twisting section, where two dough pieces are combined and twisted. Selection of the twist desired can be made in a matter of minutes—along with the adjustment for a looser or tighter twist.

Five principle parts make up a typical molder-twister-panner. These include an infeed conveyor, sheeting head, molding conveyor, twisting head, and panner. In production, the dough pieces are placed on an infeed conveyor, flattened or sheeted, dusted with flour, curled and delivered to the molding belt in a straight line. The curled dough pieces on the molding belt pass under two pressure boards which seal and extend the dough pieces to proper length.

As the dough pieces leave the molding conveyor they trip a dough flap, actuating the dough traps and twisting mechanism, then drop into the selecting trap. The selecting trap opens each time the dough flap trips, and deposits successive pieces into each of two pockets of the collecting trap. Both sets of twisting cups operate on every second opening of the selecting trap.

The collecting trap releases the dough pieces in pairs into the first set of twisting cups. The cups rotate 180 degrees in opposite directions applying the first two twists, then deposit the partly twisted loaves into the second set of cups.

The second set of cups also rotates 180 degrees in opposite directions, applying the third and fourth twists, if both cups are in place, or only a third twist if one of the second set of cups is replaced by a stationary plate. The twisted loaves are then held on the panning trap which deposits them into pans traveling on a conveyor.

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Circle 660 on Page 131

phasis on air safety and the advantages of an airport control system that includes means of storing information received by radar.

A new type miniature envelope, called the "match box" design, applicable to a complete line of receiving tubes and using the same electrode structure as conventionally designed receiving tubes, also has been developed by Westinghouse. Although the design has future commercial application, development efforts have been concentrated on fulfilling the needs of the military.

Because of the new envelope configuration, improved circuit performance has been obtained. Reliability improvements beyond that possible with conventional tubes are realized because the tube stem is eliminated and all lead welds to the mount structure are in one plane which makes the welds more accessible and subject to control. Mechanized feeding of tubes to printed circuit boards and chassis is now possible because of the rectangular shape of the new family of receiving tubes.

Department Store Group Evaluates Data Processing

BUILDING BLOCK approach to the installation of electronic data processing equipment and systems in retail stores has been suggested by the Electronics Committee of the Retail Research Institute of the National Retail Merchants Association.

Harry Margules, Controller of Gimbels, Pittsburgh, and chairman of the committee and the R.R.I., noted that "although a concept for integration of procedures is desirable, it appears impractical for stores to install in the beginning a completely integrated system." The committee recommended that installation of electronic equipment and systems be begun in specific functions and then extended block by block through the entire store.

To assist retailers in developing practical electronic data processing installations, the committee has assigned permanent areas of responsibility to its members to correspond with major department store functions. Those areas include: Selling, personnel, receiving, merchandise control, accounting and control, credit and accounts receivable, as well as electronic equipment and installations, and the concept of electronics for retailing.

The committee has discussed the problems of premarking and preticketing systems. Some retailers are exploring the merit of a card activated marking machine which would make possible the integration of certain aspects of the buying, receiving, and selling functions. This could be accomplished without the necessity of having standardization of ticket content. The group plans to review point-of-sales equipment at a meeting in September which manufacturers of equipment will be invited to attend.

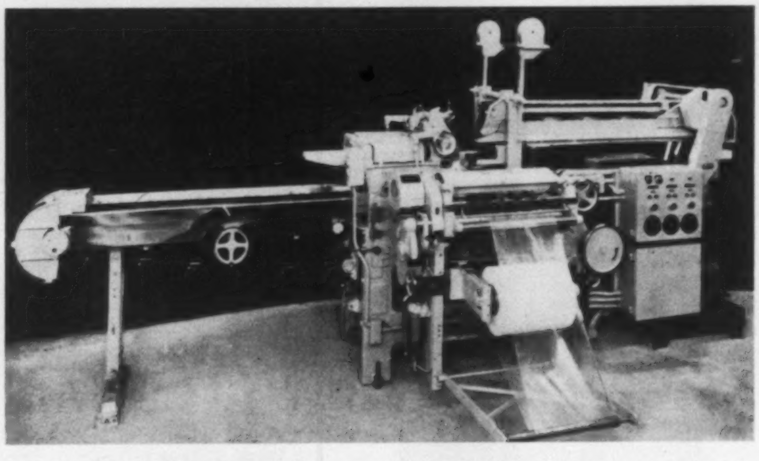
AUTOMATIC flaw detector developed by Metrol Inc. checks flaws, physical properties, and dimensional variations in metal tubing, bar stock, flat stock, and wire. Unit employs electromagnetic eddy currents to probe for defects or deviations from specifications. Flaw alarm is given by loudspeakers or lights. Detector can be installed on a production line for 100 per cent inspection and is available with a mechanism which grasps the part and propels it through test coils. Faulty parts can be diverted by the unit to bins or a flaw marker can daub paint on the flaw for cutting out or identification.

Welding Machine Manufacturer Celebrates Twenty-fifth Year

CELEBRATING its twenty-fifth anniversary, National Electric Welding Machines Co. has announced the installation of an automated welding production line costing in excess of $1 million to produce distribution transformer tanks for a large electrical manufacturer. The line includes many resistance and arc welding machines combined with other metal forming equipment.

Twenty-five years ago National's first order was for a small dual-air-operated spot welding machine to weld rear track-pants on toy wagons. The equipment was designed without a single machine tool in the plant except pattern making equipment. The metal machine work was "farmed out," and the equipment was delivered to the customer in 31 days.

Since that time, National Electric has grown into one of the leading producers of welding equipment. Complete automation is made pos-



WRAPPING machine for weld-sealing unsupported polyethylene and other soft plastic films has been developed by Battle Creek Packaging Machines Inc. At speeds up to 75 packages per minute, the machine will overwrap items within the following range: $4\frac{3}{4}$ to $12\frac{1}{2}$ inches long; 3 to 8 inches wide; and $\frac{1}{2}$ to $4\frac{1}{2}$ inches high. The machine can be furnished with either end-fold or underneath fold. Seal produced by the machine is of such quality that new methods by which a consumer can open a sealed package are being investigated.

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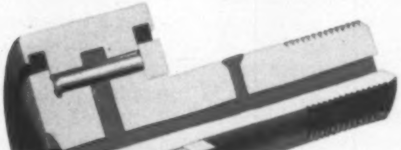

Effective sealing of the CAMROL cam follower against moisture, dirt, chips, etc. guarantees longer service life . . . reduces maintenance. This sealed construction retains lubricant and eliminates need for frequent relubrication, so often undesirable in cam action, guide support and track roller applications.

Special seals are built in at stud and flange ends. A black oxide finish on all exposed surfaces offers outside corrosion resistance. The channeled reservoir above the rollers in the outer raceway bore helps store reserve lubricant, sufficient in most cases for lifetime service. Relubrication is possible through convenient oil holes. The new SCF sealed CAMROL cam followers interchange with proven standard CAMROL cam followers. Standard stock with roll diameters up to 4″ are available for both stud and shaft mounting.

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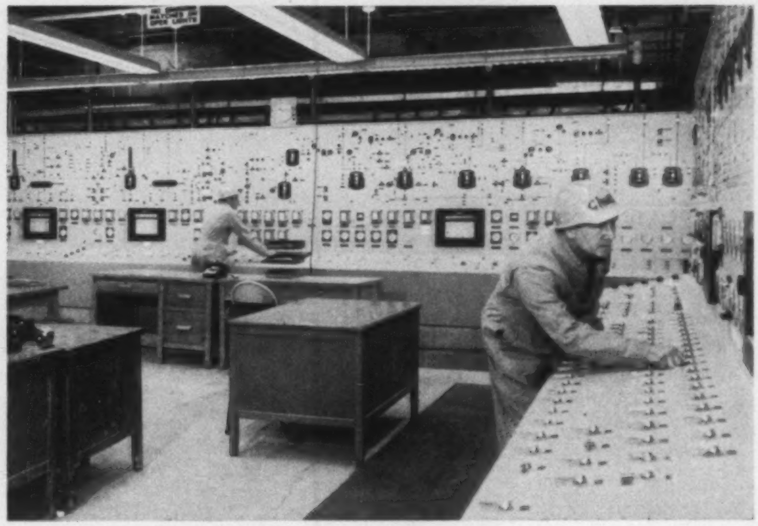
Circle 661 on Page 131

sible in National's welding machines by utilizing automatic feeds, dial feeds, automatic positioners, multihead design, automatic discharge devices, motor-driven rotating fixtures, and sequenced ejectors. During the past several years, National Electric has designed, built, and installed a great many automated production lines.



PRODUCTION of boron-based chemical fuel for use in future fighters, bombers, and missiles has been started at a new high energy fuel plant built by Olin Mathieson Chemical Corp. for the U. S. Navy. A portion of the control panel that monitors the entire fuel producing process is shown above. The new plant will mix boron, hydrogen, and other chemicals to produce High Energy Fuel-2 which can increase the range, speed, or payload of aircraft and missiles because of its greater heating and burning values. The new facility will be operated by Olin Mathieson, and shipments of fuel will be made to both the Navy and Air Force.

British Equipment Performs Routine Chemical Analyses

SYSTEM of instruments that will perform exacting scientific tests, record their findings, and take proper corrective action when necessary, all without human help, will be introduced to the American market by Chicago Apparatus Co., distributor of laboratory equipment. Called the Analmatic, the instruments are made by Baird & Tatlock Ltd., Great Britain, and are extensions of a basic system the company designed and built for the British Atomic Energy Authority. The system is designed to free the scientist from routine analytical work in certain types of analyses.

The equipment performs following operations: 1. Collects a succession of exactly measured samples of the material to be analyzed. 2. Mixes the successive samples with metered amounts of reagents, as necessary. 3. Heats or agitates the solution as required. 4. Performs the necessary test by color measurement, by titration to pH, by potentiometric or "dead stop" end points, by photometric measurement, etc. 5. Records the test results as graph or dot diagrams, or in digital form. 6. Thoroughly washes all the pipettes and other vessels used to hold liquids, insuring that there is no contamination that will affect subsequent tests. 7. If the analysis shows that the test material deviates from a given critical value or range, a visual or aural alarm is given. If desired, the alarm can be replaced by a control system that will adjust the production process automatically, compensating for the previous error.

CONVEYOR drive system with a $\frac{1}{4}$ to 15 horsepower motor enclosed in the pulley drum is manufactured by Eberhard Bauer GMBH of Western Germany. Space-saving design eliminates need for external drive mechanisms, and totally-enclosed motor is unaffected by dust, humidity, or weather conditions in outdoor operations. American representative for the foreign firm is Georg von Opel Corp., New York.

The instrument system is priced between $15,000 and $50,000, depending on complexity of tests to be performed. Equipment is at present available only for clear liquids. Baird & Tatlock has designed apparatus for external filtration of samples and reagents entering the analyzer, but has not worked on automation techniques for testing slurries, suspensions, or solids. Industries most likely to have automatic laboratory applications include pharmaceuticals, petroleum processing, many different kinds of chemical production, paper manufacturing, food processing, and plastics production, but there is a potential place for the equipment in any production stream where liquids must be quality controlled.

Paging System Vibrates To Call Personnel

ELECTRONIC personnel calling system has been developed by AC Spark Plug Div., General Motors Corp., and is in use at its Dort Highway plant. Especially suitable for noisy production areas, the paging system summons personnel by causing a small, transistorized radio receiver to vibrate in the person's shirt pocket.

The paging equipment consists of a master console operated by a telephone operator, remote booster amplifiers, and personal pocket receivers. When a person is to be paged, the telephone operator is called and given a code designation for the pocket receiver. The operator presses a combination of buttons corresponding to the receiver's code number and flips a switch to send out the call.

The receiving device in the shirt

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Motors can be interchanged or replaced *in minutes* with the all-steel, All-Motor type FALK Motoreducer. No long and costly "down time" is involved in making the change!

Best of all, replacement is not limited to original make of motor—new NEMA frames may be substituted for old. This versatile Motoreducer operates with any make, speed or type of standard foot-mounted motor within its AGMA rating. No modification, no special shaft, no "partial" motor required.

In addition to unmatched motor interchangeability, this dependable gear drive—the "work horse of industry"—offers: widest choice of output-shaft position (horizontal, vertical, right-angle)...any output-shaft connection...any mounting, including wall and ceiling...standard speed range from 1.5 rpm to 1430 rpm. All these advantages, plus proved efficiency, low maintenance and extra-long life, make the All-Motor type FALK Motoreducer your best buy for any job requirement.

Furnished in sizes up to 75 hp with any make, style or type of motor; or, *without a motor if desired.* FALK Motoreducers are available from convenient factory, field or distributor stocks, from coast to coast.

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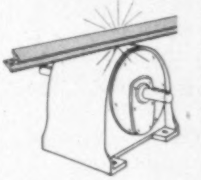
Circle 662 on Page 131

FALK "IN-BUILT" FACTORS assure full dependability—better service—longer life



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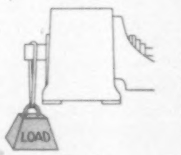

LARGE OVERHUNG LOAD CAPACITY

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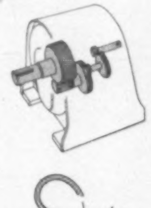
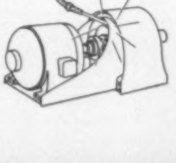


PRECISION GEARING

Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion.



SEALED HOUSINGS

Splashproof, dustproof, oiltight. Dual closures and one-way vents keep oil in, dust and moisture out.

pocket of the person called immediately vibrates and alerts the person being paged. The paging process is completed when the paged person calls the operator and receives the message.

A total of 380 receivers can be operated from each console. Each receiver is approximately the size of a package of cigarettes and weighs about 7 ounces. At the AC Dort plant about 85 receivers are now in use and up to 200 are expected to be used shortly.

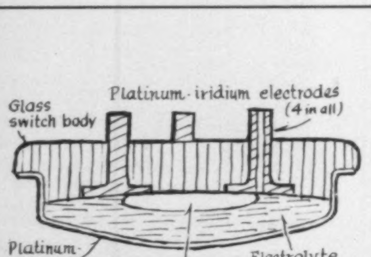
Blister Packaging Possible For Heat Sensitive Items

HIGH frequency heat source is used to seal butyrate plastic blisters or bubbles to paperboard backing in a new machine that will increase range of applications of blister packaging. Plastic blisters sealed to paperboard backing are used to provide protective, transparent packaging for a variety of small products like razor blades, novelties, and hardware. **David C. Williams,** vice president, Eastman Chemical Products Inc., a supplier of butyrate plastic from which the film is extruded, reports that butyrate blisters can now be used also to package products that would be spoiled by heat, since the high frequency method of sealing concentrates the heat directly at the point where it is needed. The process will not warp the paperboard backing as some heat sealers do, and since a welded bond is made between two surfaces, the seal will not be disturbed by changes in temperature.

Another advantage of the new machine manufactured by Erdco Manufacturing Co., is that it die-cuts the paperboard backing to which the blisters are sealed, instead of slitting it. This enables the user to obtain any shape desired—including hearts, ovals, free forms—conforming exactly to the pattern of the blister's rim.

For use with the butyrate blister, the paperboard backing is coated with a heat activated adhesive, formulated to give permanent seal between the blister and paperboard.

CUSTOM MADE keyboards in any size and key arrangement are offered by Concord Control Inc. Available in size from portable hand units to desk models, any quantity of keys and type of arrangement can be provided. Each key will operate as many as two normally opened and two normally closed contacts simultaneously. Keyboards can be used in ac or dc circuits ranging from 6 to 120 volts. Typical 20-key model shown measures 7 by 5½ by 1½ inches and has a sloped panel.


Glass switch body
Platinum-iridium electrodes (4 in all)
Platinum-iridium alloy cup
Air bubble
Electrolyte

HIGHLY-SENSITIVE leveling device has been developed by Lear Inc. Glass switch body holding four platinum-iridium electrodes is fused to an alloy cup of 5 per cent iridium and 95 per cent platinum. Cup is filled with a controlled quantity of electrolyte leaving an air bubble of exact dimensions. When switch is tilted from true horizontal, the bubble shifts position, varying the amount of electrolyte in contact with electrodes. Resultant change in conductivity and variation in current may be used to control electrical circuits to assure a true gravity-referenced position on both axes at all times.

The vacuum forming, done by the machine, essentially consists in softening the butyrate under heat and then drawing the sheet by vacuum into a female mold. After the cavities are formed, they are filled and the paperboard backing is brought into contact with the rim of the blister and sealed to it. Immediately after sealing, the steel rule dies cut the paperboard backing around each blister package, except for small tabs on each side of the package which hold the blister in the paperboard strip, or web. Cutting and sealing dies are so designed and synchronized that butyrate film between the packages can be stripped from the web and reclaimed.

Retractable Boring Tool

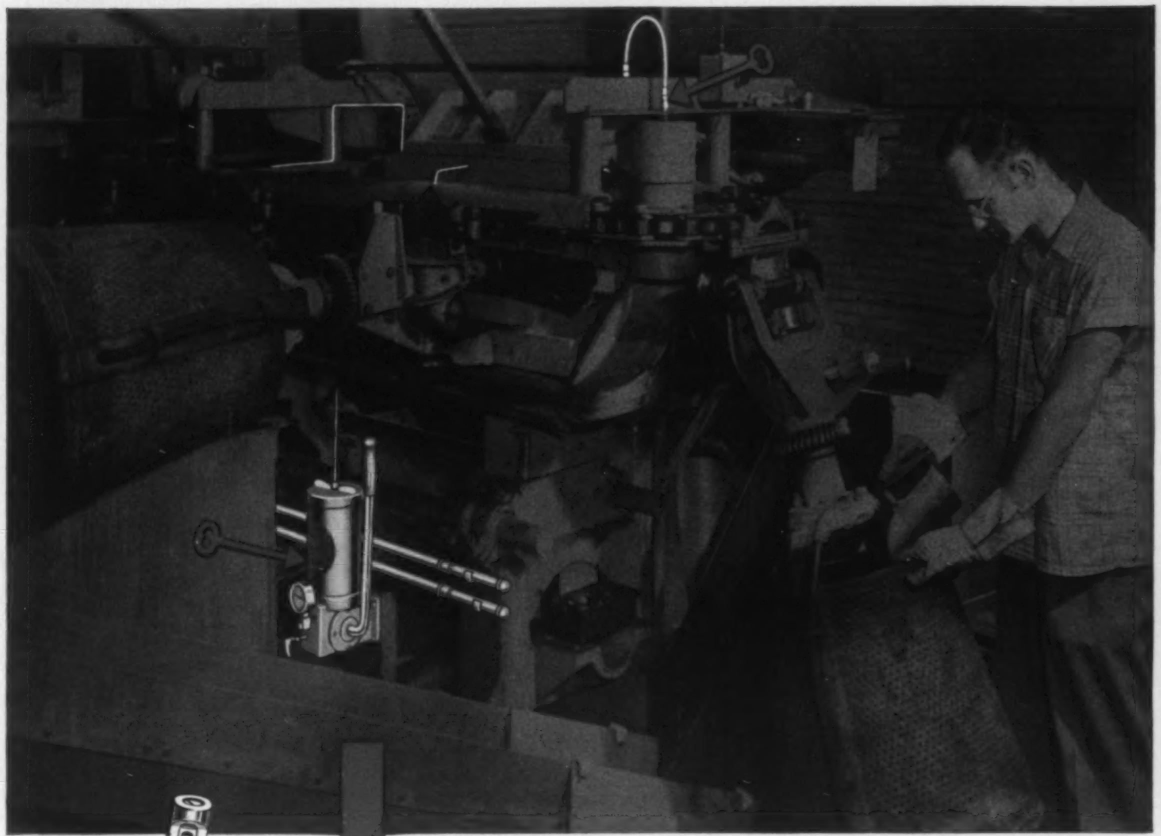
PRECISION boring head has been developed by Briney Mfg. Co. that can either finish bore a hole on the withdrawal stroke or retract its toolbit to prevent marking of the finished bored hole as the head is withdrawn. This new boring head permits retraction and feed-out to be handled automatically without interrupting the machine cycle or stopping the machine spindle from rotating.

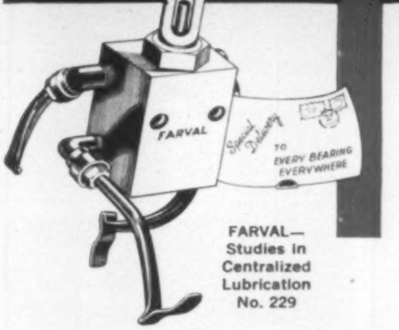
In operation, the retracting feature is used to eliminate tool drag lines on hole surfaces caused by bar deflection when boring tools are withdrawn from the finished work. In some cases, this feature also makes possible the elimination of secondary finishing operations such as grinding and honing.

A plunger located inside the machine spindle is used to control retraction and feed-out. Any conventional actuating system can be used to power the plunger movement one-half inch in both directions. The tool is retracted as the plunger moves forward into a cam located inside the boring head. Withdrawing the plunger from the cam causes repositioning to a positive pin stop that assures the same bore size on each finishing pass.

SPOTLIGHTING PEOPLE

Clarence F. Van Epps appointed director of manufacturing for the Electronics Div., Stromberg-Carlson . . . **George H. Gustat,** director of





FARVAL—
Studies in
Centralized
Lubrication
No. 229

Farval cuts downtime on automatic plating machine

Quantity production is a prime purpose for automatic machines such as this Stevens plater. Bearing failure, long the enemy of automatic processes, is eliminated on this plating machine at a prominent Midwestern automotive parts plant through application of a Farval lubrication system. Downtime for repair of bearings is virtually eliminated.

This Farval system provides measured amounts of lubricant to each bearing at regular intervals. Large ports on Farval systems insure adequate lubrication without dangerous line pressure loss or grease separation.

Learn how you can cut downtime with an application of a Farval system to your process or machinery. Ask for revised Bulletin 26-S. Write The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

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CENTRALIZED SYSTEMS OF LUBRICATION

Circle 663 on Page 131

ADEL Automates your manual machines *with* *Industrial Hydraulic Components*

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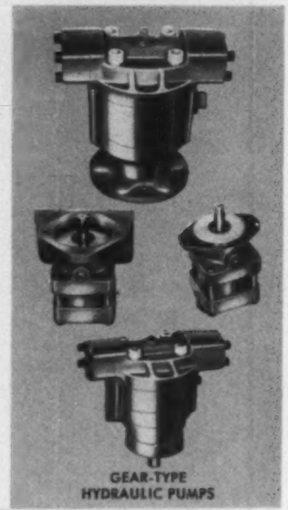

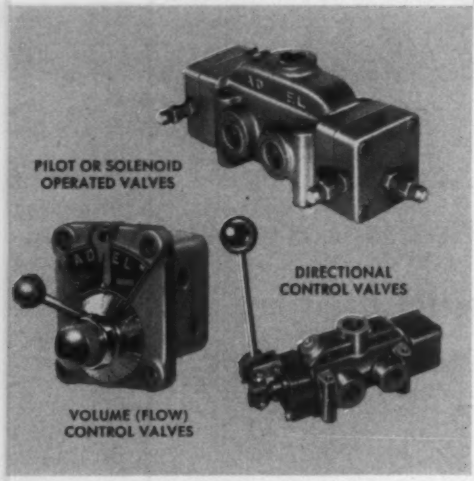
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DIRECTIONAL CONTROL VALVES
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ADEL Hydraulics' experience in the design, development and precision production of hydraulic equipment has produced components of unusual reliability, efficiency and economy. These proven Pumps, Motors and Control Valves, available in a wide variety of types, sizes and mountings, may mean new economies in your hydraulic system costs.

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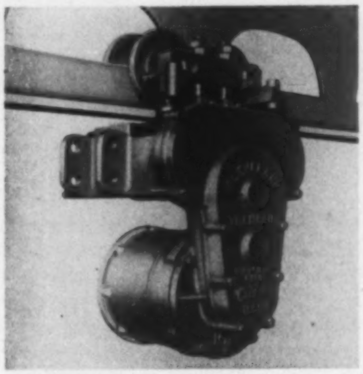
Circle 664 on Page 131

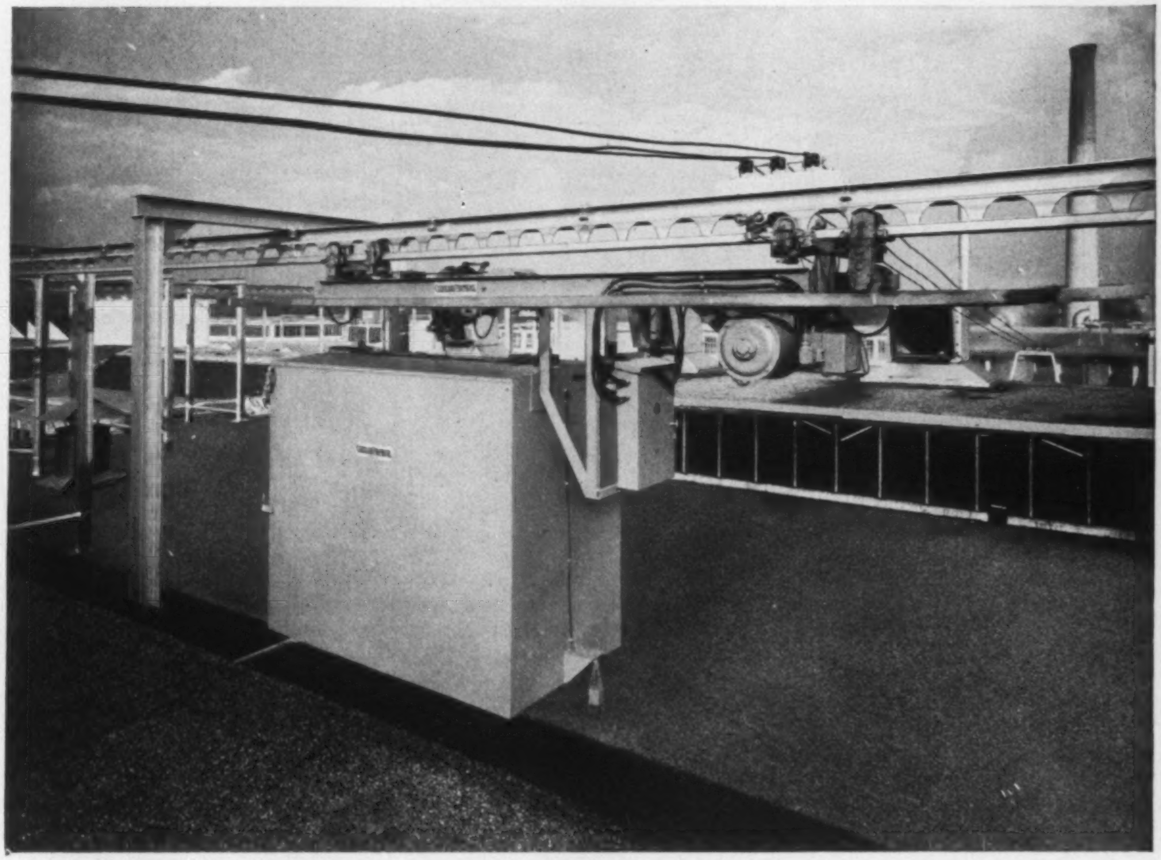
the industrial engineering division at the Kodak Park Works of Eastman Kodak Co., elected president of the American Institute of Industrial Engineers . . . **Graham Tyson** appointed senior applications engineer for data handling systems at Telemeter Magnetics Inc. . . . **George W. Fenimore** appointed assistant vice president of the Ramo-Wooldridge Corp. . . . **Cyril E. McClellan** elected vice president of engineering at the California Technical Industries Div., Textron Inc. . . . **A. W. Orlacchio** named chief engineer of the Glennite Instrumentation Div., Gulton Industries Inc. . . . **Thomas J. Ault,** former president of several divisions of Borg-Warner Corp., elected president of Saco-Lowell Shops . . . **George F. Dun** named technical assistant to the executive vice president of Emhart Mfg. Co. . . . **Robert J. Bibbero** appointed chief engineer of the Applied Science Dept., Bulova Research and Development Laboratories Inc. . . . **Woodford D. Miller,** vice president, appointed general manager of the Fulton Sylphon Div., Robertshaw-Fulton Controls Co. . . . **Frank J. Durzo** named vice president in charge of manufacturing for the Jeffrey Mfg. Co. . . . **James Peterson** joined Cyril Bath Co. as chief engineer . . . **George A. Lagassa** named vice president - manufacturing of Titeflex Inc. . . . **Gerard Q. Decker**



MOTOR-POWERED tractor for use on overhead tramrail handling systems has been developed by Cleveland Tramrail Div., Cleveland Crane & Engineering Co. Tractor is driven by two steel rollers under spring pressure against the bottom of the track and will develop a drawbar pull of 300 pounds. Depending upon the motor size used, speeds vary from 50 to 350 fpm. Tractor can be used as a single motor drive for carriers in a train or for motorization of hand power cranes and carriers.

AUTOMATIC Materials Handling System Operates On Roof

Has paid for itself several times over since installed



THE box-like structure that you see in the photograph above is a traveling van that measures 4'-0" x 8'-0" x 6'-6" high. It is built into a motorized carrier that travels over an extensive Cleveland Tramrail system built on the roof of a large prominent plant.

A large door at the opposite end of the van is swung open during loading. Pallet loads of materials are brought inside the van and set in place. 3000 lbs. can be handled with this particular unit per trip. Other larger units are available.

No special operators are required for the Tramrail system, as it can be kept going easily by the production machine operators along with their regular work. After the van is filled, pressing a button starts the load on its way. The van first travels upward until it is above the roof. Then it goes forward over the extensive track system. When it reaches the roof over one of the two receiving stations, as preselected, it makes the vertical descent to the floor. Here the door is opened and materials removed.

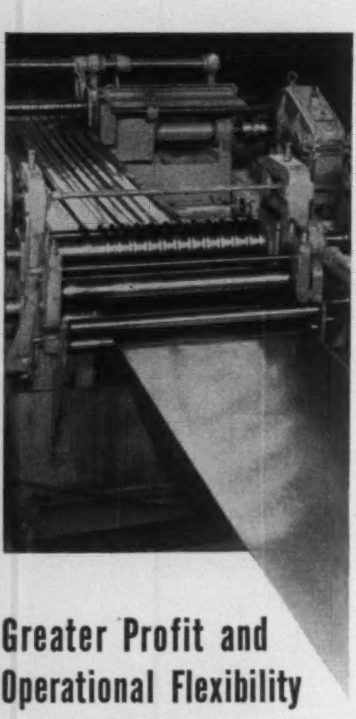
This system brings distant departments close together so that they can operate as efficiently as if they were adjacent to each other. It eliminates need of wide load-carrying aisleways — and thereby saves considerable floor space. It avoids confusion and danger of floor trucks which would normally be required. It greatly cuts costs by drastically reducing time required for materials handling. In fact, the savings made by this system have been so great that it has paid for itself several times over since installed.

Very likely you, too, can make big savings by putting to work that big unused roof of yours. Cleveland Tramrail engineers stand ready to show you how.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1320 E. 290th St. • WICKLIFFE, O.



Greater Profit and Operational Flexibility with a YODER SLITTER

Even if you use less than 100 tons of varied strip sizes per month, it will pay you to investigate the savings that are possible through the operation of a Yoder slitter. Savings per ton increase rapidly as coil size and width of strands decrease...so much, that under average operating conditions, a slitter will pay for itself in a few months.

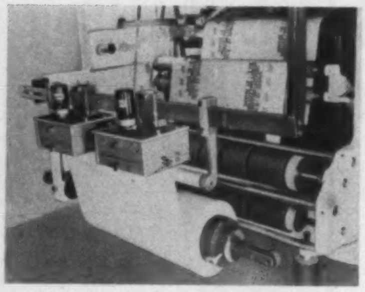
From a small stock of standard mill-width coils, a Yoder slitting line enables you to meet unexpected demands, or to supply "special" width slit strands in a matter of a few hours. This flexible operation increases plant efficiency, resulting in savings of time and money through simplified production planning and greatly reduced strip inventories.

The Yoder line includes slitters of every size and capacity for coil or sheet stock. Send for the all-new, 1958 edition of the Yoder Slitter Book. It is a comprehensive text on the mechanics and economics of slitter operations with time studies, cost analyses, and other valuable data. Write to:

THE YODER COMPANY
5526 Walworth Avenue • Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

Circle 666 on Page 131



PRINTING attachments made by Adolph Gottscho Inc. are used to print kraft paper wrappers for bundles of shaving lotions as a part of the packaging operation. The automatic roll printers are mounted over the paper feed of a Package Machinery Co. bundling machine. Weighing less than 5 pounds, each unit occupies approximately one cubic foot of space. Two units mounted in parallel print the same impression on each half of the sheet.

elected vice president of Servomechanisms Inc. . . . **Allen J. Edwards** named general manager of Datran Electronics Div., Mid-Continent Mfg. Inc. . . . **Walter H. Owen** appointed general manufacturing superintendent and **Earl L. Casey** named manager of division services for the Apparatus Div., Texas Instruments Inc.

SPOTLIGHTING PRODUCTS

Electromagnetically - powered ball bearing assembly is available for special applications where virtually torque-free performance is required. In operation, an electromagnetic device oscillates the outer ring of the supporting bearing and tends to cancel out the friction torque resisting the rotation so that starting torque equals running torque. Manufactured by Barden Corp., the bearing can be used in precision instruments such as gyro gimbals, scales, and static balancing machines. . . . *Photoelectric transducer* available from Electronics Div., Waldorf Instrument Co., features up to 50 individual outputs per linear inch. The assembly consists of closely spaced elements of light-sensitive cadmium sulfide which convert light energy into electrical signals. Each cell has an individual lead and a common ground. Device can be used to read control signals from film, punched card, or perforated tape. . . . *Deep hole drilling* of small holes ranging in diameter from ⅛ to ½ inch and 44 inches deep is a new service offered by the Gage and Instrument Div., Sheffield Corp. In materials of consistent structure, hole straightness can be held within 0.001 inch per foot for the entire depth of hole, and diameter tolerances can be held to 0.0003 inch. . . . *Subminiature neon lamps* with integral internal ballast are available from Circon Component Corp. Improvement of electrode structure and gas content of the lamps provide sufficient increase in light output so that they may be used in panel installations where incandescent lamps were required. Lamps consume only ¼ watt of power at a design current of 2 milliamps and have a life expectancy of 5000 hours.

SPOTLIGHTING PLANTS

Tomkins-Johnson Co. has started construction of a new manufacturing plant and office at Jackson, Mich. The 111,280 sq ft plant will approximately triple the existing plant and office space and should be ready for operation by the end of the year. . . . **Telecomputing Corp.** has announced the purchase of Autron Engineering Inc., designers and manufacturers of electronic and mechanical high-speed counters for data instrumentation systems. The new acquisition will become a part of Telecomputing's Data Instruments Div. located at North Hollywood, Calif. . . . **Westinghouse Electric Corp.** has selected a site in Muncie, Ind., for a new power transformer manufacturing plant. Although construction has not been started, the plant is expected to be ready for production by early 1962 and will employ more than 2000 people. . . . **Atlantis Engineering Corp.** is a new manufacturing firm with offices and plant at Garland, Tex. The firm will design and manufacture manual, semiautomatic, and automatic test equipment for the semiconductor industry. . . . **Landis Machine Co.** has announced the purchase of Maiden & Co. Ltd., Cheshire, England. The new concern will be known as Landis Machine-Maiden Ltd. and will manufacture bolt and pipe threading equipment for sale in Europe. . . . **Illinois Tool Works** has acquired the assets of Pacific Solenoids Inc., El Segundo, Calif. . . . **Curran, Bayliss and Glasgow Inc.** has been recently formed to provide management consulting services in Chicago in the field of data processing methods and procedures. . . . **Consolidated Electrodynamics Corp.** has completed construction of two 57,500 sq ft buildings for its Systems and Transducer Divisions in Monrovia, Calif. The Transducer Div. designs and manufactures sensing devices used in dynamic and static testing systems, and the Systems Div. designs and builds instrumentation systems for high-speed electronic data processing, dynamic and static testing, chemical analysis, and industrial control.

MEETINGS AND EVENTS

Aug. 5-7—

American Institute of Electrical Engineers. Special Conference on Non-Linear Magnetics and Magnetic Amplifiers to be held at Hotel Statler, Los Angeles. For additional information contact G. C. Anderson, Autonetics Dept. 388-64, 9150 E. Imperial Highway, Downey, Calif.

Aug. 11-13—

Western Packaging & Materials Handling Exposition. 1958 Show to be held at Civic Auditorium, San Francisco. Additional information is available from Clapp & Poliak Inc., 759 Monadnock Bldg., San Francisco 5, Calif.

Aug. 13-15—

Conference On Electronic Standards and Measurements. Jointly sponsored by AIEE, IRE, and the National Bureau of Standards, conference will be held at the NBS Boulder Laboratories, Boulder, Col. Additional information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Aug. 19-22—

Western Electronic Show and Convention. Sponsored by the Los Angeles and San Francisco Sections of IRE, and the West Coast Electronic Manufacturers Association. Event to be held at the Pan Pacific Auditorium and the Ambassador Hotel, Los Angeles. Further information is available from WESCON headquarters, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Sept. 7-12—

American Chemical Society. National Chemical Exposition and Conference to be held at International Amphitheatre, Chicago. Additional information is available from ACS headquarters, 1155 16th St., N.W., Washington 6, D. C.

Sept. 15-17—

American Society of Mechanical Engineers. Process Industries Conference to be held at Hotel Statler, Buffalo, N. Y. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 15-19—

Instrument Society of America. 13th Annual Instrument-Automation Conference and Exhibit to be held at Convention Hall, Philadelphia. Further information is available from Fred J. Tabery, 3443 S. Hill St., Los Angeles 7, Calif.

Sept. 22-24—

Standards Engineers Society. Seventh Annual Meeting to be held at the Benjamin Franklin Hotel, Philadelphia. Additional information is available from F. F. Van Atta, 1916 Race St., Philadelphia 3, Pa.

Sept. 29-Oct. 3—

American Society of Tool Engineers. Western Tool Show and ASTE Semiannual Meeting to be held at the Shrine Exposition Hall, Los Angeles. Further information is available from Richard Gebers, ASTE headquarters, 10700 Puritan Ave., Detroit 38, Mich.

AUTOMATION

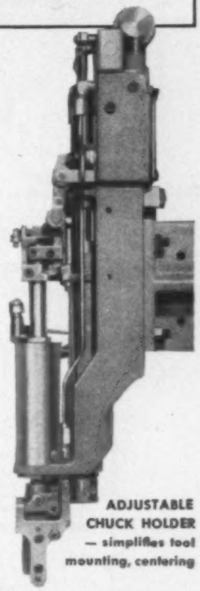
SAVE TIME AUTOMATING SMALL PARTS ASSEMBLY OPERATIONS

SPECIFY

DIXON

"Auto-Positioner"

FITS IN SMALL SPACE—21" X 3¼" X 5" DEEP



ADJUSTABLE CHUCK HOLDER — simplifies tool mounting, centering

- **STANDARD HEAD DESIGN**—Saves engineering time. Easy to apply to variety of jobs. Operates on ordinary 80# air pressure, 110 volts. Has machined T-slot surface, simple adjustments. Tooling, mounting column, feeders, etc., optional.
- **BUILT-IN SENSING**—Acts as automatic inspector, assures quality production. Machine stops if part is missing or malformed.
- **FAST, VERSATILE**—Handles wide range of feedable metal or plastic parts from 1/16" to 3" O.D. at speeds up to 100 cycles per minute. Easy to tool.
- **PRECISION-BUILT**—Sturdy frame, one-piece super-finished piston and rod, cushioned air cylinder, J.I.C. controls.
- **WRITE FOR FULL DATA**—New circular gives complete specifications, shows typical applications.

DIXON PARTS ESCAPEMENTS
Releases single parts or in multiples at speeds up to 200 per minute. Standard models available for air, solenoid, or mechanical operation.

DIXON

DIXON AUTOMATIC TOOL, Inc.
2312—23 rd AVENUE
ROCKFORD, ILLINOIS

Equipment for Automatic Parts Handling and Assembly

Circle 667 on Page 131

Man's Eternal Struggle with the Machine

PROFITS ARE BEING SQUEEZED BETWEEN RISING MANUFACTURING COSTS AND THE NEED FOR COMPETITIVE PRICING!

The front office does know how critical your specification of equipment is . . .

Obviously, you and the other men in your plant, who devise production processes and select equipment, literally control the company's ability to make its product competitively.

That competitive ability earns the profit the company must have to stay in business.

Thus, you and the others, who specify equipment purchases, deal as directly with your company's profit as do the Board of Directors and entire executive staff.

Sciaky knows your important relation to the company's profits, too. That's why Sciaky resistance welding and production equipment is built to satisfy the requirements of *your* particular application. That's why Sciaky equipment is tested and proved to do *your* job *before shipment.*

As a result, it's easier for you to do a better job. You get the right equipment at the right price . . . you need only a minimum of time and cost for production tryout . . . you don't suffer from excessive rejects or re-work operations.

Why take less than the full advantage of consulting with a Sciaky Application Engineer the next time you are considering equipment. No obligation, of course.

A major manufacturer of air conditioning units took that advantage. As a result his production requirements were satisfied with a relatively low cost, versatile assembly line of standard welders adapted with simple tooling. The excessive cost of a complex, fully automatic machine (which was originally thought necessary) was avoided. Write for "Resistance Welding At Work," Vol. 4, No. 10 for details of this ingenious solution.

SCIAKY®

64A

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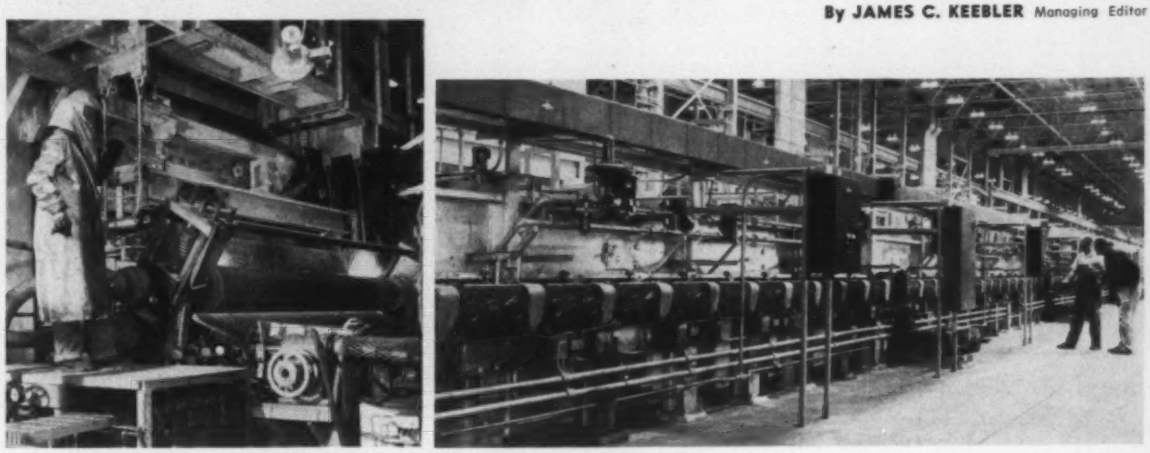
Circle 668 on Page 131

detroit dateline

By **JAMES C. KEEBLER** Managing Editor



At Ford's Nashville glass plant this ribbon of glass emerges from the furnace (left) and passes between water-cooled rollers at a temperature of 2240 degrees. Attendant in heat-resistant clothes views the taffy-like orange ribbon. Ribbon moves into a 430-foot long lehr, or oven, (right) in which it is slowly cooled to 150 degrees under controlled conditions. At this stage of the plate glass production process the material is in one continuous ribbon for the entire length of the lehr.

Glass Goliath

SINCE THE START of the 1957-58 recession much has been reported about the vital role the auto industry plays in the nation's economy. Supply lines of materials going into auto production extend into almost every industry. Glass, one of the basic materials in the modern car, requires ingredients from a wide variety of sources and provides a good example of the far flung nature of the influence of Detroit. The fact that the purchase of your new Edsel means business for the charcoal makers of Ridgley, Tenn. may not have been obvious to you.

Staggering Proportions

Whether the industry makes 5 or 8 million cars a year depends on whether or not people are buying them. In an economy where the customer is free *not* to buy, the problem of keeping them coming back each year can be a big job. Yet making 'em by the millions is also a staggering problem and the plant facilities must be ready to meet the market when the stumbling sales curves stagger upward again.

The Automobile Manufacturers Association reports that on the basis of the 1954 Census of Manufactures, the industry's glass purchases in the laminated plate glass category came to $177½ million. Though the 109½ million square feet that this represents sounds like a lot of glass, it must be remembered that Ford is also in the do-it-yourself category when it comes to glass manufacture.

As a result of Henry Ford's vision of self-sufficiency, the first Ford glass flowed from an experimental tank set up in a corner of the powerhouse at the company's Highland Park plant in 1919.

Continuous Process

To overcome the costly and time-consuming method of batch casting, Ford asked his engineers to experiment with adaptations of England's Pilkington process, in which glass was passed through forming rolls and annealed as a continuous sheet. After overcoming many obstacles in the Highland Park experiments, the principles of mass production for which Henry Ford became world famous were successfully applied to glass manufacturing.

The year 1923 saw Ford sales at an all-time peak with a growing demand for closed models, which raised glass requirements. In August of that year, a new glass plant was opened at the sprawling Rouge plant in Dearborn. The company also purchased a large glass plant at Glassmere, Pa., in 1923.

Additional glass capacity was obtained in 1926 by establishing a glass furnace in the Twin Cities assembly plant at St. Paul, to take advantage of nearly pure silica sand which was mined directly beneath the plant. This facility produced glass sheets for fabricating at other plants for interrupted periods until 1958.

While the makeshift glass operations were discontinued at Highland Park in 1926 and the Glassmere plant was sold in 1931, a multi-million-dollar expansion and modernization program was started at the Dearborn glass plant in 1935 to greatly increase capacity.

New Colossus

The Nashville, Tenn. plant is the newest Ford plant to be opened to the view of the nation's reporters and is billed as the world's largest complete glass-producing facility under one roof. This covers 30 acres of a 237 acre site, and makes Ford the fourth largest glass producer in the U. S. and the third largest maker of plate glass.

Planned for a capacity production

requiring 2500 employees, the giant plant houses two furnaces having a daily yield capacity total of 395 tons, enough to cover nine acres.

While sheet glass is drawn from one furnace, plate glass is rolled from another to feed a narrow, race track-shaped grinding and polishing line 4000 feet long.*

Passing under 64 grinders and 100 polishers (each the width of the glass), the "brackets" of glass are finished to a 0.003-inch tolerance at 0.125-inch thickness. After thorough cleaning and inspection, the glass is cut to windshield size and formed into "wraparound" shapes.

Combined into a "sandwich" with a center sheet of vinyl plastic, two panes of plate glass are laminated or bonded together by a pressure-cooking process in hot oil. As these "safety glass" windshields are again washed and inspected they move by conveyors to packers and are readied for shipment by truck or rail.

The shapes produced at this plant number 40 in all, including seven different windshields, eight front vents, eight front door pieces, three rear door shapes, nine distinct quarter windows, one rear vent, and four different back windows.

Mammoth Appetite

One of the major reasons for locating this giant in Tennessee is that he's near his food supply—the lists of materials in the recipes for the product and the process ingredients call for much material supplied by southern states.

In one production year the Glass Division facility uses almost 200,000 tons of Tennessee sand, which is mined at Camden, 80 miles from the plant site. Approximately two-thirds of this amount is grinding sand, and the balance is more thoroughly washed silica sand.

Other raw material supplied primarily by southern states include soda ash, 19,000 tons, Louisiana; limestone, 12,000 tons, Anderson, Tenn.; salt cake, 5500 tons, Texas; feldspar, 1500 tons, North Carolina; and charcoal, used in small quantities since it comprises less than one per cent of batch weight, from Ridgley, Tenn.

From other states the plant buys 13,000 tons of dolomite, a rock consisting of calcium and magnesium carbonate used as flux; 6000 tons of plaster to hold the glass firmly on grinding and polishing tables; 1000 tons of rouge and copperas which help polish glass, and 2000 tons of sheet vinyl used as the middle section of laminated safety glass.

Among liquid raw materials used in a year are 225,000 gallons of lubricating oils, which cook the "sandwiches" in lamination as well as serve plant equipment, and 310,000 gallons of muriatic acid employed in grinding and polishing.

Jumbo Automation

Such quantities suggest to automaters the vast scope of automatic operations required in the manufacture of glass. Besides the on-the-spot considerations of automatically feeding the furnaces that continually melt glass, controlling temperatures and flow, and automatically operating the block-long lehr and the grinding and polishing lines there is the added problem of providing standby utilities.

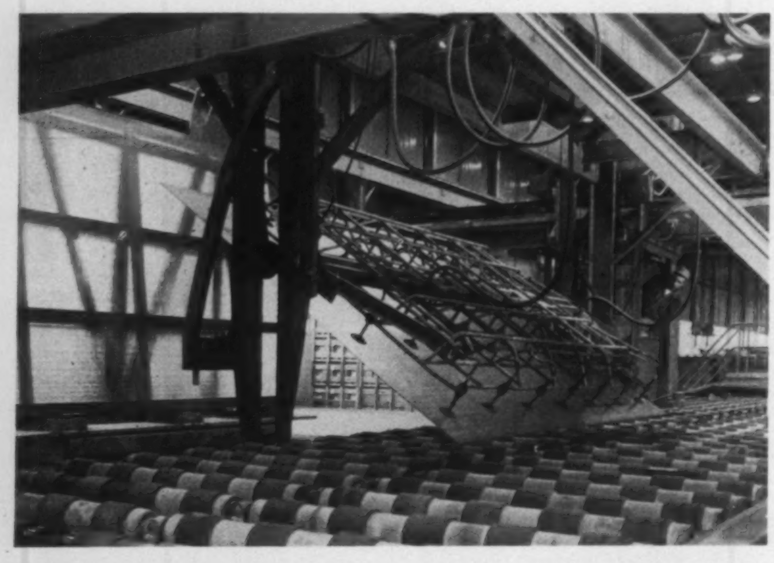
The courage required to attempt operation of such large facilities must be backed-up with emergency measures to be employed in the event of a failure. If gas supply is halted, propane standby equipment automatically begins to supply production operations, and fuel oil assumes demands for plant heating. In the event of failure in the 18,500 gpm supply of water pumped from the Cumberland River, an automatic switch is thrown to draw a sufficient supply from city lines for cooling operations at the furnaces.

A diesel-driven pump is mounted alongside the electrically-operated pumps on the barge that draws river water for processing. There is dual electric service between the utility company's area substation, the main plant substation, and critical equipment within the plant.

Once a large-scale continuous process of this nature gets rolling it must be pampered. Production cutback or shutdown must conform to procedure and not be by random failure or you soon have a lot of problems on your hands.

Such highly automated facilities provide the wherewithal to meet mammoth market requirements.

P.S. The charcoal removes the excess water created in the furnace by the addition of salt cake which prevents formation of unmelted scum on the surface of the molten glass.



Since furnaces are in production every day of the week at Ford's Nashville glass plant, and faster processing lines operate on a five-day basis, it is necessary to store some rough plate glass to keep lines filled. This 120 by 170-inch unfinished piece is being semiautomatically stacked for later grinding and polishing.

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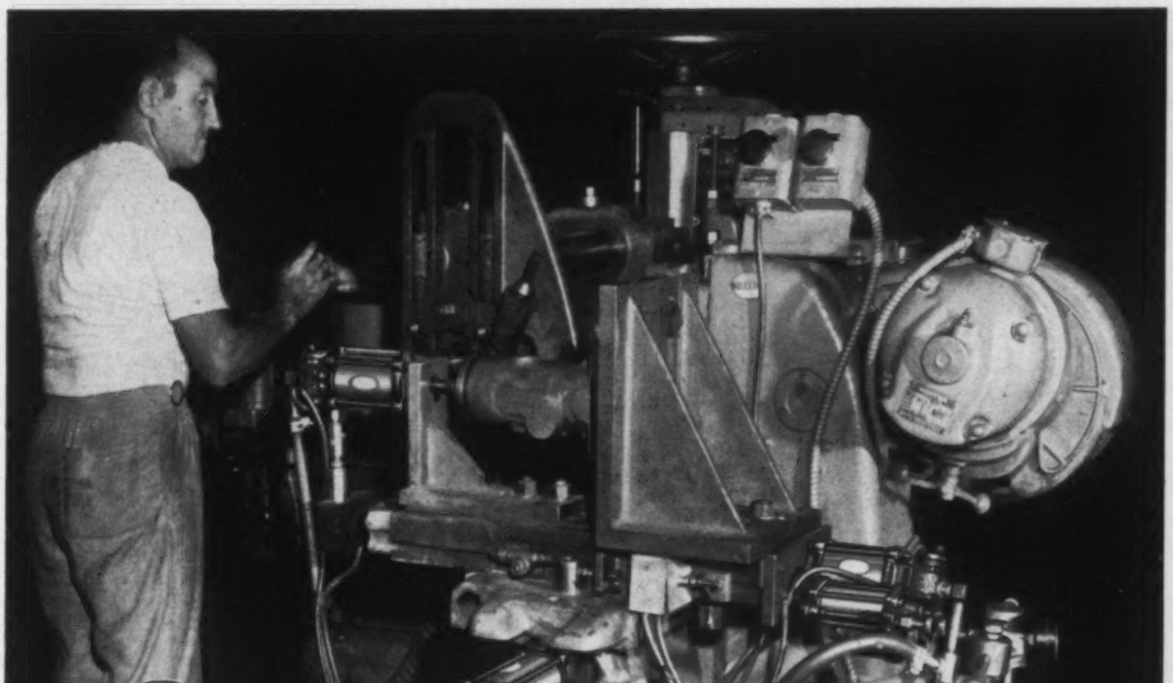
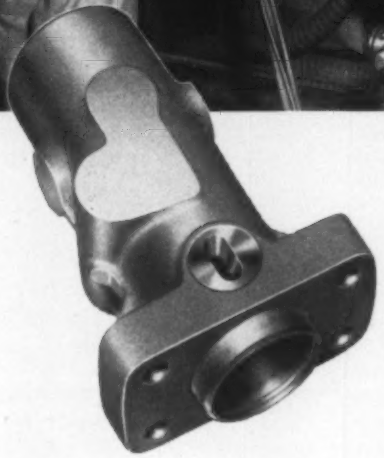
*"Grinding and Polishing Plate Glass," AUTOMATION Vol. 4—No. 11, November 1957, page 43.





"He took a dim view of the whole idea"

As reported by the foreman of a department at American Bosch, Springfield, Mass.: "We were milling a tapered slot in a 30 lb. housing for a CQ pump. When I told the operator we were going to "automate" the milling operation with Bellows Air Motors, he said "ixnay", he didn't want any part of it.

"You should have seen him at the end of the first day. He went home like he was walking on daisies. 'Baby', he said, 'with this Bellows equipment, milling these 30 lb. housings is a lead pipe cinch.'

"He was happy. We are happy. He gets home in the evening fresh enough to play around the golf course, and we, well, we're getting better tolerances, better finish, at less cost".

** from the case history files of The Bellows Co.*

* * *

Wherever Bellows Air Motors and Bellows air-powered production units are used to convert manually operated units to automatic machines, you'll find both operator and management singing their praise. To the operator, Bellows equipment brings less fatigue, greater safety — to management, a better product at lower cost.

This may be helpful

If your catalog files on Bellows "Controlled-Air-Power" Devices are not up-to-date, ask us to send you a new complete catalog.

Write Dept. AU-858 The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto 18, Ontario

1147-B

The Bellows Co.

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO

western roundup

Hawthorne, Calif.
By GILBERT C. CLOSE

Producing holes is the quantity operation permitting mechanization in this sheet metal job shop. Variety of hole patterns are punched in fins that will be assembled to cooling or heating coils. Company has developed multistage die in which hole patterns can be varied by simple lever operation.

From Little Acorns

AUTOMATION exists where you find it—and it can be found in industry being applied where academic logic would lead you to believe that it couldn't be applied. Two such "exceptions" were visited by the writer during the past month. One application was in a sheet metal job shop where heating, air conditioning, and ventilating equipment is largely custom-produced in relatively small lots. The other application was, of all places, discovered in a job shop devoted exclusively to working with the highly temperamental and unpredictable titanium alloys.

Press Operation

The first application mentioned above was found at the Drayer-Hanson Div. of U. S. Radiator Corp., Los Angeles, a concern devoted largely to custom-building of heating, ventilating, and air conditioning equipment. The only operation that even approaches a mass production status at Drayer-Hanson is the manufacture of the numerous fins which are installed in each product and perforated in a manner to contain the heating or cooling elements which coil back and forth through the perforations.

A few years ago a fin press was installed which would accept roll sheet stock of the proper width, then perforate it according to the pattern of the punching die. While this was a definite advancement, it still had its drawbacks. Because of the numerous different fin patterns produced, rolled sheet stock had to be stocked in a great variety of widths, and after each relatively short production run, the fin press had to be shut down while its dies were changed.

Fred Savaglio, Plant Manager at Drayer-Hanson, began toying with the idea that the efficiency of the fin press could be vastly improved by equipping it with a multiple-stage punching die with each stage controlled by an external lever. Thus, by merely flipping the levers, the pattern produced by the die could be rearranged almost at will.

As a result of the easily controlled and highly variable die patterns, only three widths of strip stock need now be kept on hand. This has reduced inventory requirements by one-half. When a production run of one type of fins has been completed, the press operator (now only one man is required) merely has to flip the proper levers to change the punching pattern for the next. In addition to changing the punch pattern, the amount of "kick-up," or extruded metal around each punched hole which is used to control fin spacing in the finished part, can be adjusted at will.

Spinning Operation

The second automatic machine, doing yeoman service in a job where according to academic theory "it just wouldn't work," is installed in the shop at Titanium Fabricators, Inc., Burbank, Califonia, and is used to automatically hot spin titanium hemispheres used in fabricating the spherical pressure vessels which, since development of the "missile shape" in industry, are being so widely used. To most engineers, the thought of any type of automated operation on the highly temperamental and variable titanium alloys would seem almost ludicrous. It would seem even more so in conjunction with metal spinning, long considered more of an "art" accomplished by "human feel" than a routine mechanical process. Yet this company-developed automatic titanium spinning machine is now producing a wide variety of titanium hemispheres with an assurance that leads to an accurately predictable waste allowance on each production job.

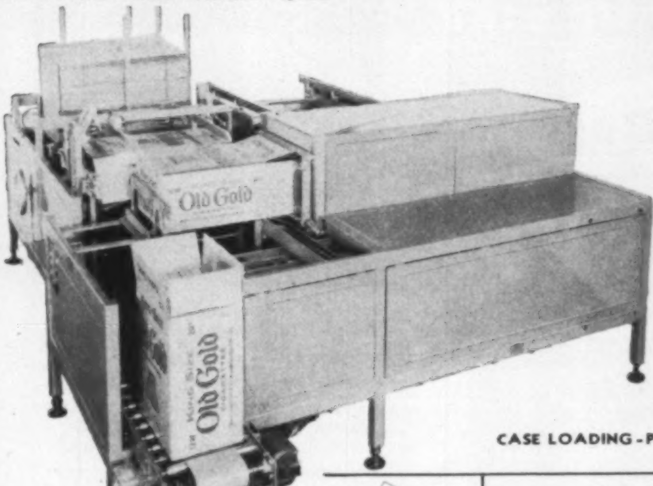
The machine itself was entirely shop-built. A vertical boring mill

Circle 670 on Page 131→

Which Packomatic solves your production line problem?

T.M. Reg. U. S. Pat. Off.

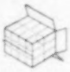
PACKOMATIC Feeder - Former - Positioner - Upender

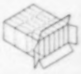


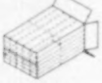
Require a fully automatic case loader?

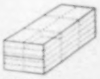
Here's a fully automatic case Feeder-Former-Positioner-Loader that is breaking records on actual production line conditions in a variety of industries. And by end-loading techniques, savings on paper board alone run as high as 28%. Production jumps dramatically with this high-speed, continuous-motion machine. Labor costs are lower, too, because except for hand-stacking corrugated shipping containers in flat form into the magazine, everything's automatic. Below are some of the end-loading patterns showing number and packing of cartons. Check with Packomatic engineers if your loading pattern does not appear here. Custom-engineering will produce a Packomatic for your product.

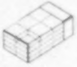
CASE LOADING - PATTERNS:

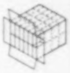

Twenty-four cartons
in 12½" x 10⅝" x 8½" case

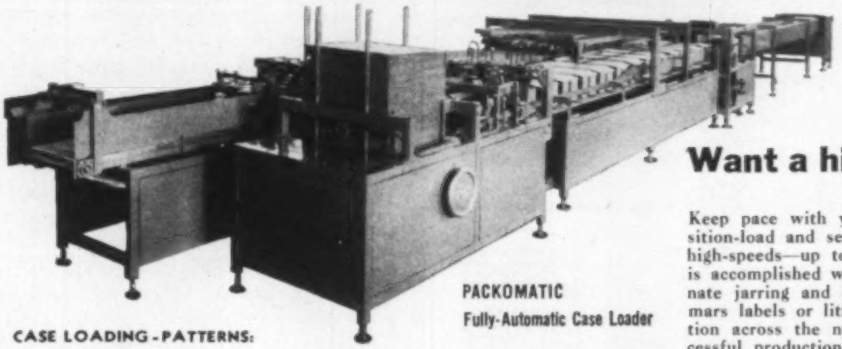

Eighteen 7 & 8 oz. cartons
in 20" x 14⅞" x 8⅝" case


Sixty cigarette cartons
King Size: 17⅞" x 11½" x 22"
Regular: 14 13/16" x 11½" x 22"


Thirty 1 lb. cartons
in 16⅛" x 10 5/16" x 7¼" case


Twenty-four cartons
in 19½" x 10⅞" x 7" case


Forty-eight cartons
in 22¾" x 23½" x 15⅞" case



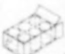
PACKOMATIC
Fully-Automatic Case Loader

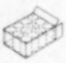
Want a high speed can line?

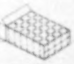
Keep pace with your production line. Now, feed-form-position-load and seal your corrugated shipping containers at high-speeds—up to 720 cans a minute—automatically. This is accomplished with a smooth continuous motion to eliminate jarring and bumping of cans that causes leakers and mars labels or lithographing. Machines in successful operation across the nation, (Packomatic was *first* with a successful production-line machine) end-load a variety of can sizes—from six 5-quart cans to twenty-four 12-oz. cans—in such patterns shown at left. End-loading reduces paper board costs. Automation saves labor costs. From corrugated flats to sealed containers, only one part-time attendant is required. Consider this time-money saver for your plant. We can custom-engineer a machine like this for you.

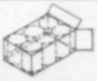
CASE LOADING - PATTERNS:

handles any can from the 12 oz. to the 5-qt. Imperial

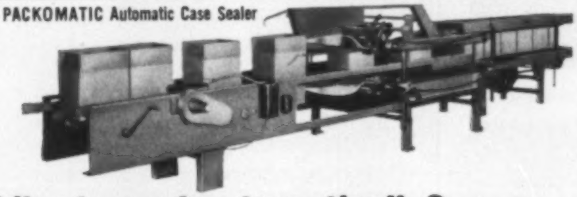
Six 5-qt. cans or gallon cans in 20⅛" x 13⅝" x 9 11/16" case and 20¼" x 13¾" x 8¼" case


Twelve 46 oz. cans
in 21" x 13" x 7⅛" case


Twenty four 12 oz. cans in 16⅜" x 10 15/16" x 5 3/16" case


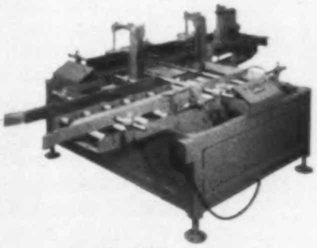
Six No. 10 cans
in 22 1/16" x 17⅜" x 7⅛" case


PACKOMATIC Automatic Case Sealer



Like to seal automatically?

Here's the machine for you — the **first** fully automatic case sealer proven under actual production line conditions. No operator needed to align corrugated cases, open flaps, glue, seal and discharge ready for shipment. Adjustable to a wide range of case sizes. Similar models, available semi-automatic.



PACKOMATIC 4-Side Case Imprinter with serial numbering device.

Need 4-Side Imprinting

Prints either or both sides and ends of corrugated shipping containers with name and contents — in addition to imprinting a serial number. Very essential if using modern palletizing methods. The only machine of its kind. Other regular models available for minimum case imprinting requirements. Write for specs and prices.

J. L. FERGUSON COMPANY **Joliet 2, Illinois**

NEW YORK, CHICAGO, CLEVELAND, BOSTON, TAMPA, BALTIMORE, PORTLAND, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE, NEW ORLEANS, LOUISVILLE, KANSAS CITY AND ALL PRINCIPAL CANADIAN CITIES.

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for Proportioning control; more precise where heating-cooling factors are more dynamic

MODEL JL SERIES
combines High Limit and Off-on control

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Portable—ideal for laboratories

MODEL JG SERIES
provides Program control, applying any of above control actions to control both time and temperature.

MODEL JS SERIES
gives Stepless control; extremely precise

MODEL JT SERIES
gives 3-Position control for motorized valves, 3-phase heating, heating-cooling cycles

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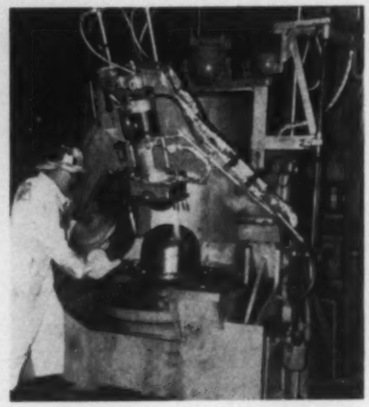
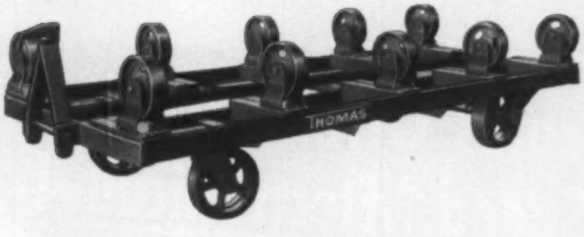


Titanium hemispheres are formed on special machine built up by Titanium Fabricators Inc. on stripped down vertical boring mill. Massive hinged yoke supports a hydraulic ram, spinning roll, and gas torches to provide controlled motion, pressure, and heat in spinning operation.

was used as the starting point, with everything stripped from the frame except the rotating table and table drive. The table was then modified to receive a variety of steel spinning dies or chucks, and to rotate them at speeds varying from 0 to 1150 rpm. Next, a large yoke was installed with its hinge axis in line with the axis of the hemispherically-shaped spinning die. This yoke hinges downward in a quarter-arc from the vertical to a horizontal position over the spinning die. A hydraulic ram was installed in the exact top center of this yoke with its axis perpendicular to the arc of yoke travel. The inner end of this hydraulic ram mounts the spinning roll which presses against the titanium blank and forces it against the spinning die as the yoke hinges downward. Both the yoke and the hydraulic ram are controlled by a 3000 psi hydraulic system. Quick-acting valves in this hydraulic system permit almost instantaneous conversion from automatic to manual control. This compensates for the highly temperamental qualities of the titanium alloys in that the operator can convert from automatic to manual control whenever an unexpected emergency so requires. Four gas torches on the yoke are located so that they preheat both the spinning die and the titanium blank, then keep them hot during the spinning operation.

Circle 671 on Page 131

SOME THOMAS "Job-Suited" TRUCKS LOOK VERY PECULIAR



This Thomas No. 396 Trailer was "Job-Suited" with inverted rigid casters welded opposite each other, on each side of the trailer so that the larger steel drums being carried could be rotated while in transport.

BUT . . . that's because they're Designed to Handle Special Jobs Faster, More Economically

Thomas builds hundreds of trucks to carry loads up to 50 tons and to work with all the latest powered equipment. Any one of these trucks can be "Job-Suited" with standard superstructures designed and built to hold your particular loads. An out-of-the-ordinary superstructure may speed up loading and unloading, carry your loads safely—save time, manpower and materials . . . actually save many times its cost.

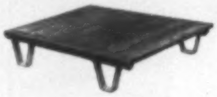
For extremely unusual or difficult handling, the Thomas engineering department can design and build special equipment to meet your specific requirements.

Endless variations for shelf trucks.

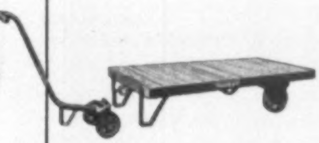
Combination dolly and live skid for lift truck use.

All types and capacities of casters and wheels.

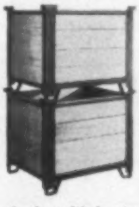
"Power-Suited" all-duty trailers, 1,000 to 10,000 lbs.



Replaceable flush top skid platforms.



Platform for use with both Jack and lift trucks.



Economical multiple-storage stacking boxes

Safety one-man drum truck

Adapted for overhead and underfloor towing.

Puts parts at machine height.

Elevated three-sided panel truck.

Rack truck for parts or tote pans.

A Thomas Representative . . .

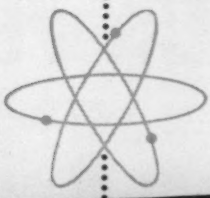
is ready to help solve your handling problems. Write for your free catalog describing the complete line of Thomas "Job-Suited" Trailers, Trucks, Casters, Wheels and "Jak-Tung" Systems.

Only THOMAS Makes "Job-Suited" Trucks

THOMAS TRUCK & CASTER CO.
841 Mississippi River
Keokuk, Iowa

Circle 672 on Page 131

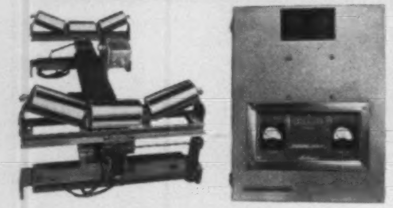
WEIGHING...



BATCHING...

TXX
LOAD CELL

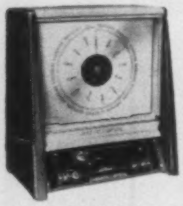
Fairbanks-Morse Scales Offer New Economy, Accuracy, Speed...Electronically!



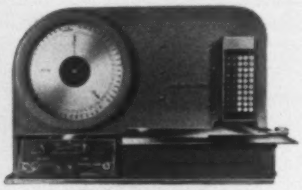
Belt conveyor scale and instrument

Read-out to auto-typewriter or tape

Punch card operated sequence batcher



Desk instrument for weighing



Desk instrument for weighing and printing

Sequence batcher for manual programming

Even Adapts to Present Mechanical Systems

Fairbanks-Morse electronic control and instrumentation permits remote location of weight recording instruments...assures automatic balance detection...automatic ranging without drop-weights...automatic zeroing...pushbutton recording and much more.

This same electronic control of weight measurement can be employed to streamline your batching operation. You can select precise quantities of all materials...in proper sequence...at the push of a button. Or you can put the batching formula on a punch card and do the whole job automatically.

Weight readings can be fed to automatic typewriters, adding machines, tape punchers, etc. Chances are your present lever system can be converted to electronic operation.

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Circle 673 on Page 131

AUTOMATION

AUGUST 1958

Directly Co-ordinated

Unless competition becomes a significant element, the matter of minimum production cost of product components seldom receives more than cursory study. Often, to fulfill rising market demand, production quantities are merely increased to suit. The vital area of design for specific volume production receives scant attention. Why, when costs are so directly affected?

As a rule, management structure has developed along separate lines regarding product design and manufacturing engineering. And, in the words of one vice president in charge of manufacture, "there is a heavy brick wall between the two." To merely expect optimum results without specific reorganization and delegation of responsibility is to lose the race.

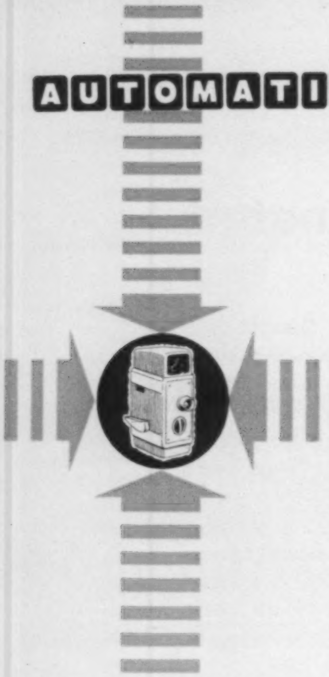
The design engineer works to specify and the production or manufacturing engineer strives to economically produce products that will function properly and fill customer's needs. Although utterly opposed in essential outlook, it is imperative to realize that design and production are intimately related. Good design and production engineering prod one another ahead. Some new product designs force the manufacturing engineer to develop, or invent, new methods of manufacture. But all of industry's techniques and every advance in the art of manufacture must be exploited for lowest costs.

Mutual understanding and exchange of knowledge between these two groups can be highly beneficial generally, but in the field of automation, success and fundamental economics dictate equal recognition of these two functions, with manufacturing engineering commanding the key position in many instances.

For real dollars and cents results today the basic functions of product design and manufacturing engineering must be directly co-ordinated. In this issue the DePro team method used by Bell & Howell is outlined. Authorities maintain that both functions must be responsible to the same manager to effect a realistic move into any level of automated production. Two factors are present: 1. A particular design for conventional manufacture may make automation and lowest manufacturing cost impossible. 2. A minor design change of little market significance may needlessly obsolete an installation of automated equipment.

Seldom can optimum results in production design be obtained by conventional means. A vital new "total thinking" approach is needed to make automation and rock-bottom production costs a reality. Divided responsibility must be eliminated.

EDITOR



NEW PRODUCT PLANNING NEEDS

MANUFACTURING TEAM FOR AUTOMATION

Getting the design for a new or a revised product into production with adequate consideration of automation economics requires real organization. The number of people involved and the degree of organization is determined by the conditions of a particular business, but Bell & Howell Co. has established some guide posts which can be helpful in both large and small companies.

By **D. J. YOMINE,** Manager, Production Engineering, Bell & Howell Co., Chicago, Ill.

TO FIND the ways and means to satisfy the ever-growing demand of the consumer for higher product quality and lower price, industry must use every bit of its manufacturing creativeness. Progressive management must place an increasing emphasis on the organization structure that will best encourage this creativeness. It will be progressive management that will emphasize interdepartment understanding, encourage a spirit of teamwork, and emphasize the need for fulfilling over-all marketing objectives. Interdivision understanding will also help greatly in attaining the over-all objectives, which of necessity include full utilization of the many advantages available through application of automation techniques in manufacturing operations.

Organization Factors

Effective organization is built around five important factors. These are: 1. Management support. 2. Common objectives. 3. Delegation. 4. Specialization. 5. Teamwork. Let us explore an organization structure that meets these requirements; *Fig.* 1 shows the specific departments that are essential in forecasting, developing, designing, and manufacturing of new photographic products.

Management support implies management understanding of product design requirements including research, engineering, testing, and manufacturing; of the importance that the design has in the sale and function of the product; of the fundamental influence of manufacturing techniques.

In the organization charted, management support is apparent in the direction and support of the respective division responsibilities by top management. Furthermore, top management is aware of the details required to efficiently carry out their division's functions and responsibilities. The lines of communication to other divisions are essential to complete interdivision understanding and total company effectiveness.

Common objectives of merchandising, engineering, and manufacturing must include knowledge of the nature of the product, the estimated sales forecast, the estimated engineering and tooling costs, the tentative selling price of the product, the proposed engineering and manufacturing schedule, and desired date of product availability.

A common objective is achieved through the lines of communication derived from this organization structure. When top management so specifies, all divisions can take common appropriate action to meet requirements. Lines of communication within the respective divisions are also related directly to the common objectives.

Delegation means giving the responsibility always to the department or engineer that is best equipped to handle any specific problem rather than to have a number of departments or people with mixed responsibility in the problem. Of equal importance are the staff services which are a continuing vital factor in the accomplishment of the total merchandising, engineering, and manufacturing cycle of the product.

Within the framework of this organization structure, delegation of responsibility for specific tasks can also be made. When tasks or responsibilities are delegated to the department and/or project engineer, they have unrestricted choice in their relationships with other departments when working out the product planning, design engineering, and manu-

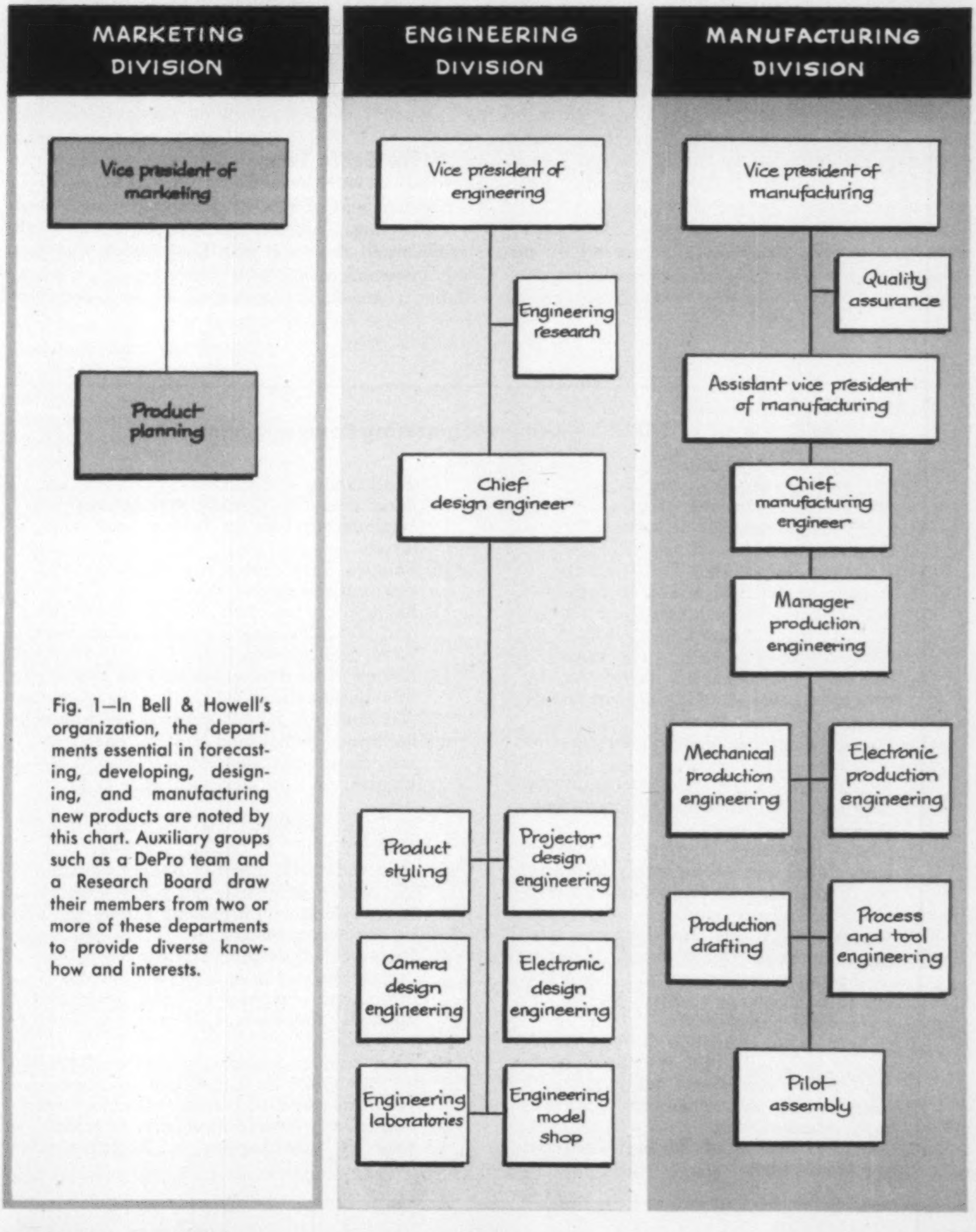

MARKETING DIVISION
Vice president of marketing
Product planning
ENGINEERING DIVISION
Vice president of engineering
Engineering research
Chief design engineer
Product styling
Projector design engineering
Camera design engineering
Electronic design engineering
Engineering laboratories
Engineering model shop
MANUFACTURING DIVISION
Vice president of manufacturing
Quality assurance
Assistant vice president of manufacturing
Chief manufacturing engineer
Manager production engineering
Mechanical production engineering
Electronic production engineering
Production drafting
Process and tool engineering
Pilot assembly

Fig. 1—In Bell & Howell's organization, the departments essential in forecasting, developing, designing, and manufacturing new products are noted by this chart. Auxiliary groups such as a DePro team and a Research Board draw their members from two or more of these departments to provide diverse know-how and interests.

facturing engineering requirements.

Specialization of product designers and manufacturing engineers results in the designing and manufacturing of high-volume quality products at a competitive cost. Design specialization is best accomplished if a designer can be assigned similar products to design. Specialization is also attained from this organization structure by the creation of separate departments to handle designs of similar products only. Further staff assistance is supplied by the Engineering Laboratories which specialize in photography, mechanical, metallurgical, and chemical engineering activities which support the product designer.

Another example of specialization is the manufacturing staff service furnished to product design by the mechanical and electronic production engineering departments. Specialization continues to be a must because of the more exacting sciences required in forecasting new product demands, because engineering is increasing in complexity, and because manufacturing must use the latest production methods and processes.

Teamwork between merchandising, engineering, and manufacturing is necessary to gain a clear understanding of each division's objectives, responsibilities, and problems; to keep lines of communication open so that each is aware of product changes, schedule changes, cost changes, and styling changes; to avoid duplicating each other's efforts; to get the product to the customer in the shortest possible time.

Because of the unrestrictive relationships between the interdivisional and interdepartmental activities, teamwork will evolve as a by-product of the organization structure. Representatives from merchandising, engineering, and manufacturing combine to make up a task force which also stimulates close co-operation and teamwork. To further effect teamwork, a "DePro" team consisting of a product engineer and a production engineer is formed. A DePro team is set up for every new product or major design change. The spirit generated by using a DePro team is shown in the interest in each other's work and helps immeasurably in the creation and continuation of team effort.

▶ The DePro Team

Development of new products begins with Product Planning. This group defines the nature of the product and reviews it with Engineering. Engineering then assigns a product designer, i.e., a project design engineer, to correlate design engineering re-

TABLE 1—Design Engineering Responsibilities

1. Write design specifications.
2. Make preliminary layout.
3. Get three-dimensional model through Engineering Model Shop.
4. Establish DePro team.
5. Review model and layout with production engineer for manufacturing capabilities, rough tooling costs, and to determine target manufacturing costs.
6. Review with Research Board for approval to proceed with engineering design.
7. Establish project design release date with Research Board.
8. Review design and manufacturing capabilities of associated components through DePro team.
9. Make necessary layouts to develop each detail and subassembly by design group assigned to project design engineer.
10. Review design and manufacturing tolerances through DePro team, including method of manufacture and dimensioning to facilitate economical tooling and component manufacture.
11. Submit detail drawings through project design engineer with specifications for materials, finishes and lubrication.
12. Consult with styling through project design engineer.
13. Get functional model through Engineering Model Shop.
14. Send model to Engineering Lab for test.
15. Send model to Quality Assurance from Engineering Lab for testing and opinions.
16. Release final design specifications and performance specifications.
17. Review model with Product Planning and Merchandising for appearance, features, and function.
18. Review final cost estimate with Production Engineering.
19. Get Research Board approval for manufacturing, using model data, engineering lab specification data, final cost estimates, and quality assurance approvals.
20. Release design for manufacturing through product design engineer who then aids with product design consulting and continues to be part of DePro team through pilot assembly and quality assurance testing.
21. Have project design engineer attend coordination meetings on new products to determine component parts, assembly methods, processes, and manufacturing capabilities.
22. Keep project design engineer available for one year as consultant on design problems occurring during manufacture.
23. Assign any design problems after one year of manufacture to Engineering Lab.

sponsibilities from the prescription of initial design specifications through the first year of manufacture. An outline of the design engineering responsibilities is given in TABLE 1. These activities include the establishment of a DePro team composed of the design project engineer and a production engineer.

After design engineering has completed the new product design specifications and made a preliminary layout, a production engineer is assigned to assist the product designer and therefore becomes part of the DePro team which engineers quality of the product at the lowest cost.

Production Engineering activities and responsibilities, TABLE 2, supplement new product development. During this cycle of new product development the production engineer is in continuous liaison with the product designer and he supplies a specialized manufacturing engineering know-how. The common goal becomes an integrated objective for the designer and the production engineer. The designer prescribes the specifications and functional design requirements and the production engineer establishes the minimum cost of manufacture.

In the organization the DePro team represents two separate divisions. The best interests in design and manufacture of the product are served by this organization structure. It must be thoroughly understood that organizing for this type of function takes much more than just changing an organization chart. The DePro team concept and philosophy must be thoroughly understood and supported by management and department supervisions before it can be expected to work at the engineering level.

▶ Meeting Objectives

With the necessary over-all company support, the DePro team will produce the best quality designs at the lowest competitive costs. Using the DePro team in the organization will also create stronger teamwork and understanding between engineering and manufacturing. The many benefits that such teamwork gives are apparent in the informal but efficient relationship shown in the co-operation between each group and in the complementary know-how each contributes to the whole project.

The new product sales target price must not be overlooked. The production engineer furnishes product cost estimates to the designer to insure that the design will meet the sales target price. The design reflects the most economical and modern manufacturing methods, processes, and techniques through continuous cost analysis by the production engineer.

The DePro team will be most effective by encouraging the attitudes of: 1. Spirit of co-operation. 2. Constructive criticism. 3. Mutual respect for each other's objectives. 4. Arbitrating questionable designs and manufacturing problems. 5. Never compromising on product quality. 6. Willingness to supplement each other's capabilities. 7. Informal relationship. 8. Making economics the basis of decisions.

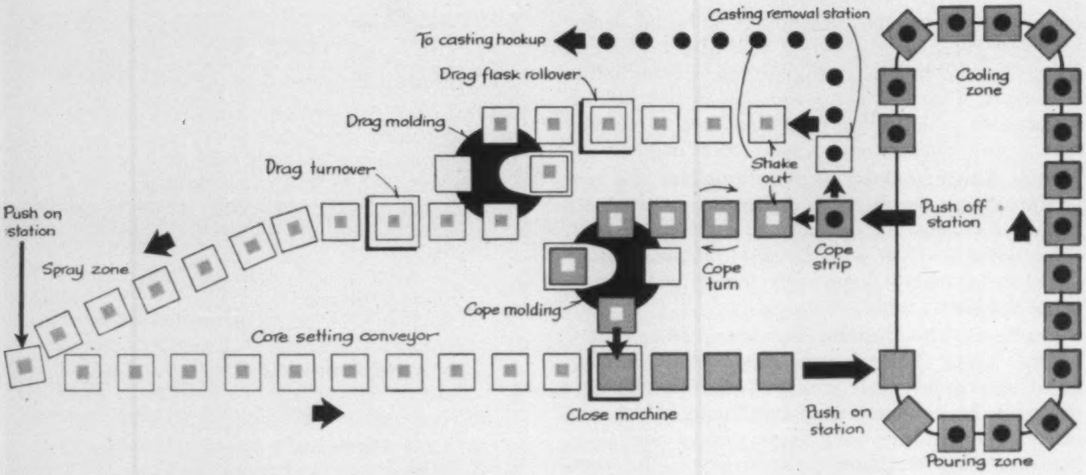
TABLE 2

Production Engineering Responsibilities

1. Assist the designer in development of product.
2. Provide preliminary and final cost estimates for product and tooling.
3. Interpret and transmit product design information to all manufacturing activities.
4. Develop new processes and methods when required.
5. Review new products to determine component parts and assembly methods, processes and manufacturing capabilities.
6. Ascertain that purchased component specifications are within industry standards.
7. Insure that product design reflects lowest cost method of assembly, i.e., automated, straight-line, or subassembly.
8. Make tolerance studies and/or layouts to:
    a. Determine tolerance accumulation.
    b. Establish the dimensional correlation between production operations compatible with design functional requirements.
    c. Establish datum reference line or surfaces to facilitate economical tooling, parts manufacture, and design control.
9. Certify for manufacture all new product design drawings before release.
10. Act as contact for providing all manufacturing engineering services to the project design engineer.
11. Review component parts and assembly deviations (due to tooling and pilot run activities) and make permanent or temporary design disposition (design engineer is contacted for disposition).
12. Issue pilot run report based on experience of pilot run by production engineer. This report includes manufacturing difficulties encountered, status of component parts, and revised figures on manufacturing time.
13. Make production engineering available as consultant on design problems occurring during subsequent manufacturing.

The DePro team at Bell & Howell clearly shows the effectiveness of an organization that has the design engineer and the production engineer work as a team pushing toward the common goal set forth by management. Though product designers have for a much longer time been a vital part of industry, it is becoming more and more apparent that the special know-how of the manufacturing production engineer is a valuable and necessary part of an increasingly complicated industrial scene.

Teamwork and understanding, co-operative use of each person's special knowledge, and the use of new ideas and techniques will make automation a larger and more effective part of manufacturing processes.


Casting removal station
To casting hookup
Drag flask rollover
Drag molding
Drag turnover
Push on station
Spray zone
Cooling zone
Shake out
Push off station
Cope strip
Cope turn
Cope molding
Core setting conveyor
Close machine
Push on station
Pouring zone

1

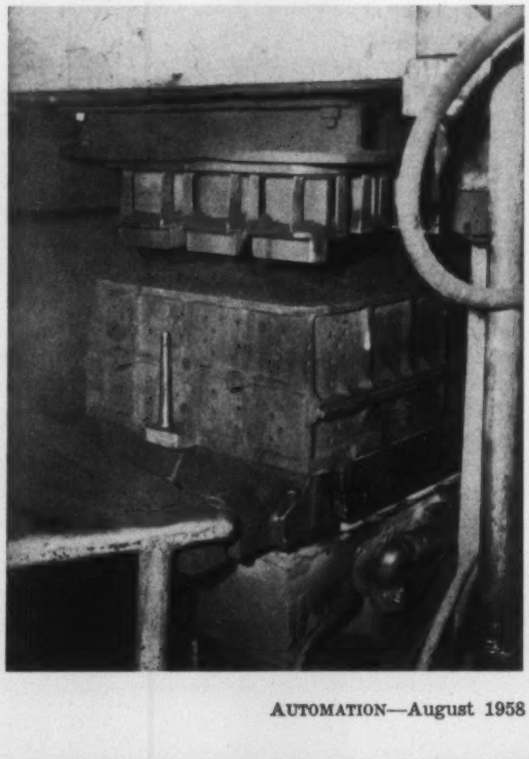
Plan view of automated foundry installation to cast engine blocks shows relative positions of major elements. The system can produce as many as 200 completed molds per hour. All movements of the heavy flasks and molds are performed automatically.

AUTOMATION TODAY

AUTOMATIC MOLD PRODUCTION

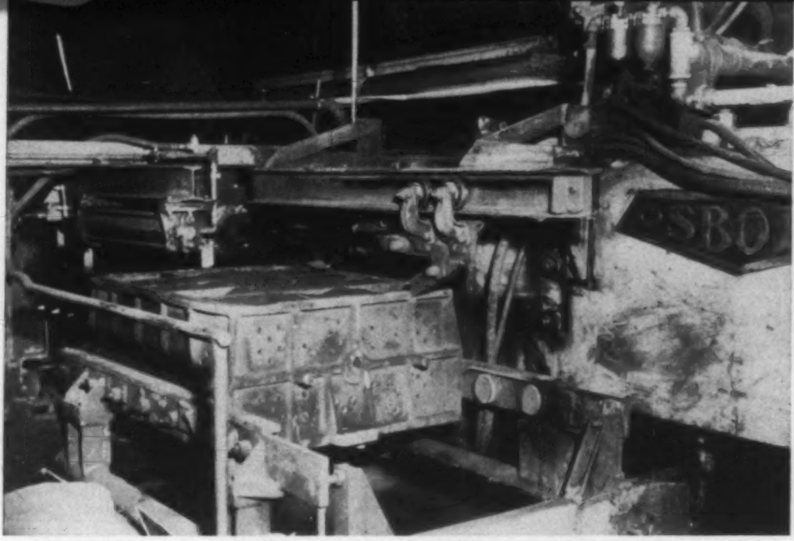
MORE THAN two years of production experience have proved the feasibility of automating cylinder block production at the foundry of the Pontiac Motor Div., General Motors Corp. This automated installation has produced an average of 150 V-8 engine block castings per hour for a daily production of 2400 engine blocks.

Not one of the 20 men required on the line has the back-breaking job of lifting mold flasks or moving completed molds that weigh some 2100 lbs. The machines which perform the molding operations are linked with automatic handling devices



2

Sand is jolted and squeezed into drag half of mold at this station of the automatic drag molding machine. Empty flasks are moved into the machine, positioned on patterns which have been blown off and sprayed with parting lubricant, and filled with a preset quantity of sand from overhead hoppers. A sand supply system provides sand mulled with the proper amount of water and binder. This molding machine is a four-station unit with an indexing mechanism that rotates intermittently to move patterns and flasks to successive stations.



3

After the pattern is automatically drawn from the drag mold at the last station of the molding machine, a piston moves the mold out of the machine into a turnover device.

so that the only manual handling operations are the setting of cores and chaplets and the hooking of castings on the cooling conveyor.

The system was designed in co-operation with Osborn Mfg. Co., and they supplied the two molding machines which are the heart of the molding installation. All drag molds are produced on one machine, and all cope molds are produced on the second machine.

Both machines are four-station rotary indexing units which receive empty flasks, position them on prepared patterns, fill them with a desired amount of sand, jolt and squeeze the sand into a finished mold, and strip the mold from the pattern. Operations are broken down among the four-stations as follows:

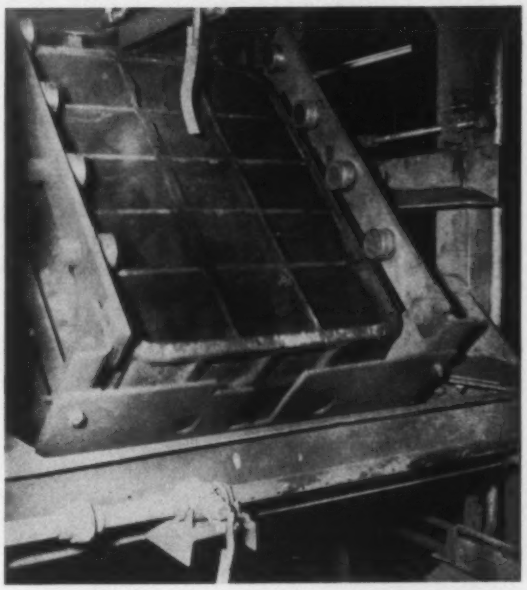
1. At the make-ready station the metal pattern is blown off by an air jet and then sprayed with a parting lubricant.

2. At the filling station an empty flask is positioned over the pattern, which moves up, picks up the flask, and makes it ready for filling. Further upward motion results in the opening of hopper gates and release of a predetermined amount of sand into the flask from an overhead hopper. Pattern, flask, and sand are then lowered onto the indexing element.

3. At the jolt-squeeze station, the jolt-squeeze action takes place with the mold and pattern plate lifted free of the indexing mechanism.

4. At the stripping station the mold and pattern are raised. The mold is supported by rollers and the pattern descends with the draw piston. The pattern then rests on the indexing mechanism and is ready for a new cycle.

After a drag mold leaves the molding machine the mold is turned over, and the casting face is sprayed with a quick-drying graphite solution. Seven core elements are assembled into a core unit in a fixture on a conveyor. This core unit is moved from the fixture into position in the mold by an operator using an overhead hoist arrangement. Placement of the core unit in the mold takes only a few seconds.

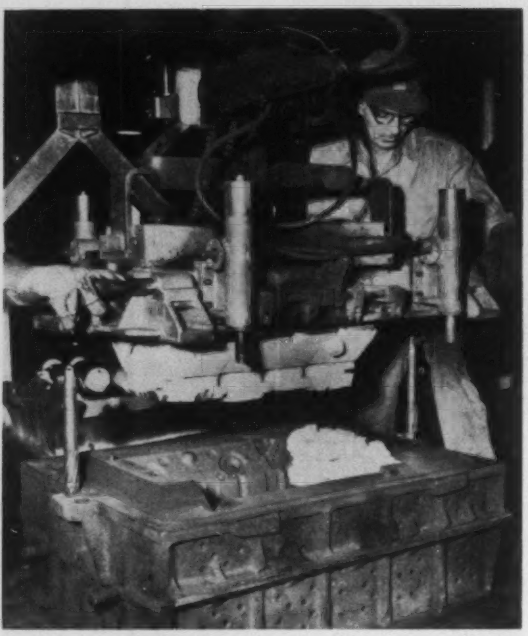


4

Since the drag mold provides the bottom part of the casting cavity, it must be turned over after molding. In many foundries this is a back-breaking manual task. Here an automatic device performs this job. After the mold is turned it is sprayed with a graphite solution to condition the face contacted by the hot metal.

The drag mold with cores in place is automatically moved into a closing machine. A finished cope mold comes to the closing machine from the cope molding machine and is positioned over the drag. The closing unit then accurately lowers the cope onto the drag and closes the mold. The completed mold is transferred to a conveyor that carries it past the pouring station. Weights are automatically placed on top of the mold prior to pouring to keep the cope from floating.

Pouring from monorail ladles is manually controlled. After the casting is sufficiently solidified, the



5

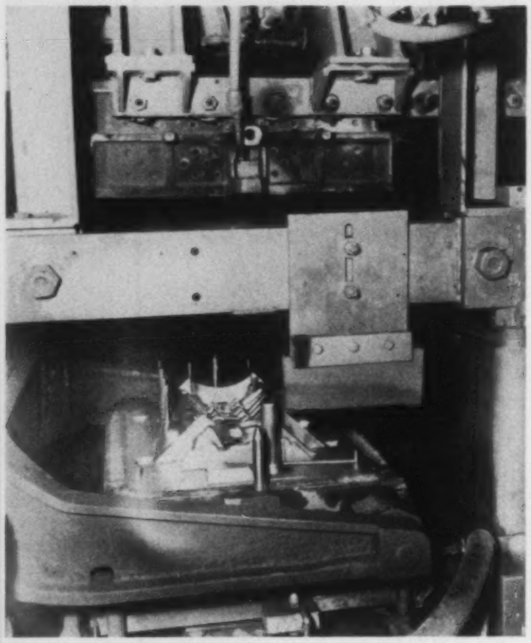
To cast engine blocks, intricate cores are required to produce the maze of internal passages in such castings. In this production setup core designs were developed which allow most of the cores to be preassembled and then placed in the mold as a single unit. Assembly of the core units is performed on fixtures on an auxiliary conveyor.

weights are automatically removed from the top of the mold. The molds continue on the pouring conveyor for a required cooling time before they are pushed into the shakeout area. The cope is lifted off, and sand is shaken out of the cope flask on a jolt unit. The flask returns to the molding machine for another cycle. The casting is lifted out of the drag, and the sand is shaken out of the drag flask by another jolt unit. The drag flask is turned over and returned to the drag molding machine for reuse. Sand is shaken out of the casting, and then the casting is hooked to a monorail conveyor and stored until it cools.

Sand from the shakeout is checked by probes, and the correct amount of water and bonding material is added automatically in the muller. After it is mulled, the sand is delivered by conveyors to the molding machine hoppers.

The various operations in the system are interlocked by electrical and pneumatic controls which can be preset for desired cycle times or production rates. A master control panel is manned at all times during operation, and all phases of the automatic system can be controlled from that point.

Pusher cylinders are used in conjunction with conveyors to move the heavy flasks and molds. The handling equipment is not part of the molding machines but is integrated with them and synchronized



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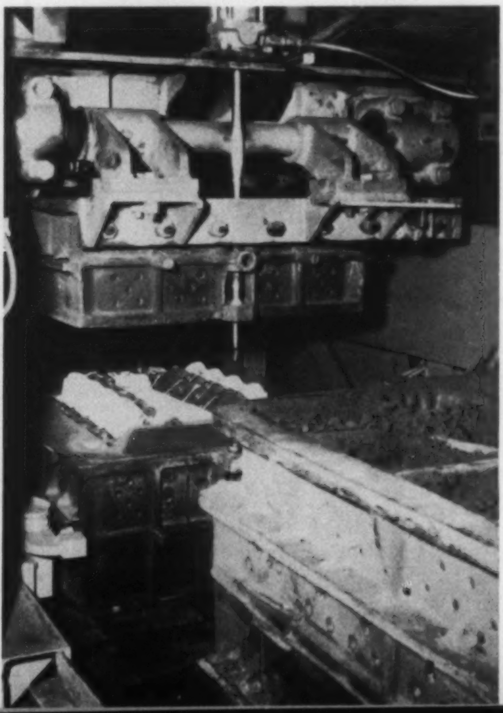
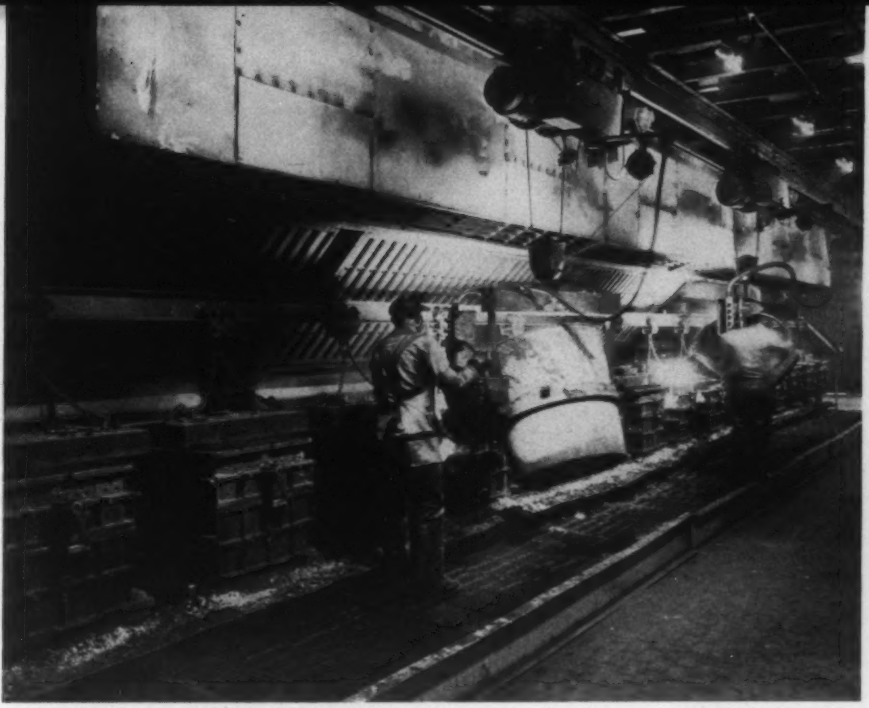
Cope halves of the mold are produced on an automatic molding machine similar to that used for drag molds. This photo shows the cope mold in raised position after the pattern has been stripped from the mold by the descent of the draw cylinder.



7

A finished cope is automatically positioned above a drag by the closing machine. It accurately lowers the cope into place to close the mold. The completed mold is then ready for pouring and is automatically pushed onto a conveyor running through the pouring area.

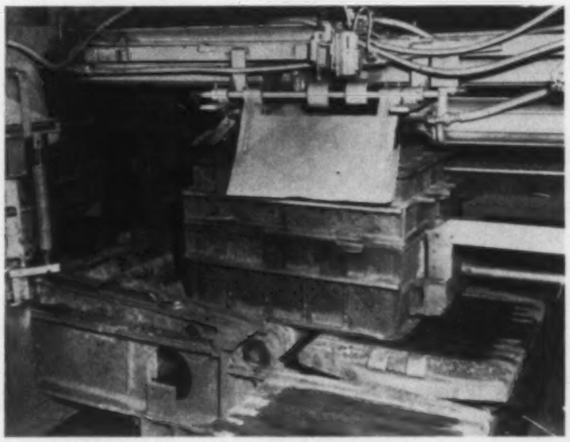


8

As molds travel to the pouring station, weights are automatically placed on top of them to prevent lifting of the cope during pouring. Metal is poured into the molds from ladles on monorail carriers. Pouring is manually controlled.

so that flasks enter the machines at the proper intervals and mold halves are removed when ready. Indexes and transfers are effected pneumatically and hydraulically under control of solenoid valves that are for the most part actuated by a master timer.

The preventive maintenance program for this foundry has been one of the reasons for its success. A four-man maintenance crew is available during each of the two operating shifts. Each crew consists of a pipe fitter, electrician, millwright, and repairman. During the third shift when the system is stopped, a crew cleans, checks, and repairs all key machinery units.



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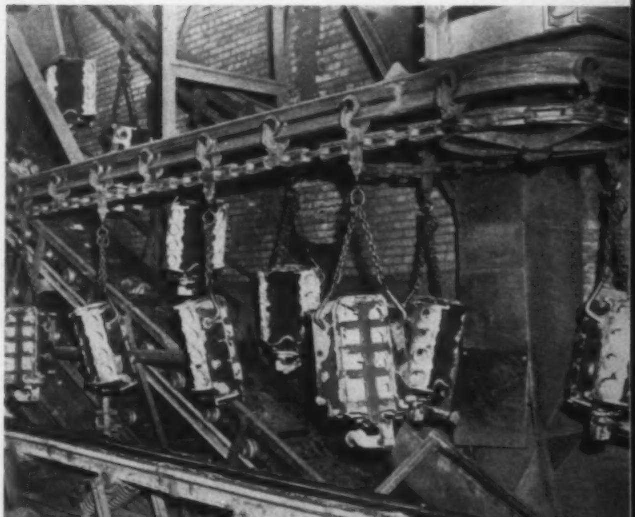
After the casting has cooled sufficiently, the mold is pushed from the pouring conveyor as shown. The cope flask is automatically removed, the casting removed from the mold, and sand is separately shaken out of the cope flask, the drag flask, and the casting. The flasks are returned to their respective molding machines by conveyors. As the drag flask returns to its molding machine, it is turned over so that it will be in proper position for molding.



10

From the shakeout the block castings travel on this monorail conveyor for cooling and delivery to subsequent operations. The blocks are manually hooked on the chains which carry them on the conveyor. Sand from the shakeout operation is returned to the preparation system. Water and binder are automatically added on the basis of readings from probes around which the sand flows.

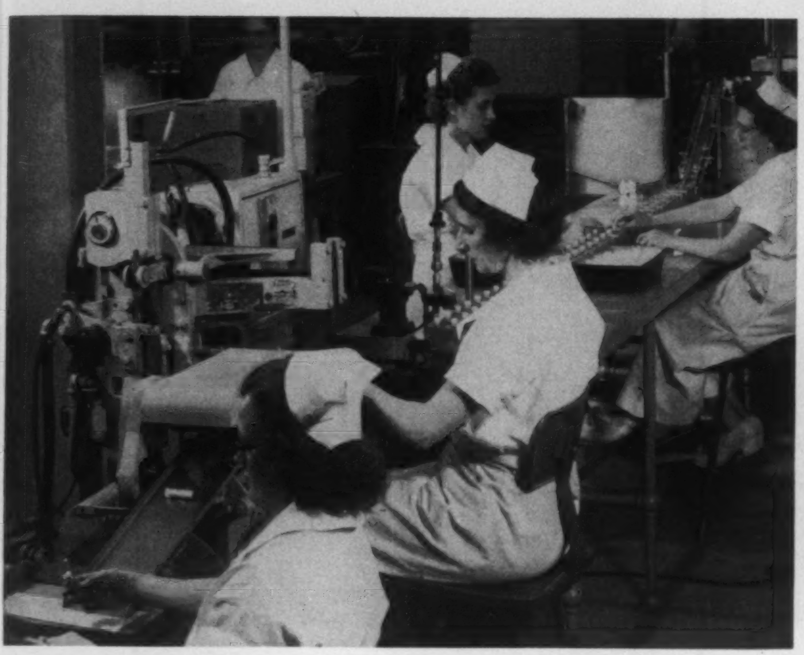


Fig. 1—Over-all view of line including machine for filling vials with tablets and seating the caps. Vials are filled automatically and plastic caps are placed loosely on their tops by operators who also perform an inspection function. A pneumatic cap-seating mechanism tamps the caps firmly in place. Filled and capped vials are delivered to labeler operator and are inspected again after labeling.

PLANT DEVELOPS OWN

PHARMACEUTICAL PACKAGER

By **SIDNEY E. HARRIS**
Dir., Pharmaceutical Production
Hoffmann-LaRoche Inc., Nutley, N. J.

AFTER the decision has been made to automate a production operation, the question often arises whether to "make or buy" the necessary equipment. This was the experience of engineers at Hoffmann-LaRoche Inc., Nutley, N. J., when it became necessary to upgrade a manual method of filling and capping glass vials to supply the needs of Roche Laboratories Div. for sample tablets.

Faced with the problems of increasing productivity to meet rising schedules, and releasing floor space for other expanding programs, these engineers first surveyed the field for commercial filling and capping equipment that could do the job. There is today no shortage in the variety of automatic equipment suitable for packaging and handling pharmaceutical products, yet this company developed its own unit, *Fig.* 1.

The primary reason for in-plant development, in this instance, was that available commercial equipment was not versatile enough as to size range,

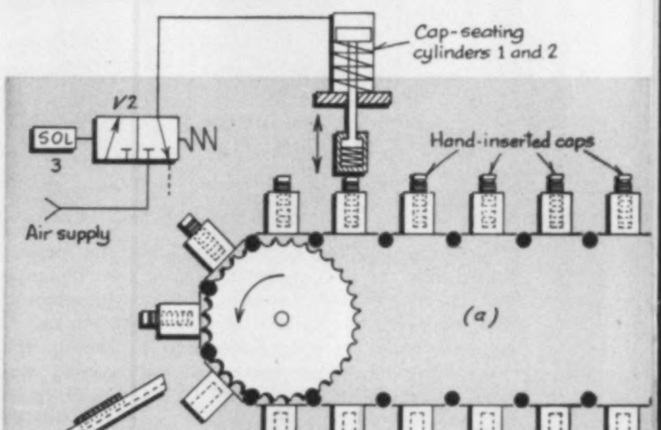

Cap-seating cylinders 1 and 2
V2
SOL
3
Hand-inserted caps
Air supply
(a)
Filled and capped vials to labeler

Fig. 2—Sketch *(a)* illustrates basic elements of machine for filling and seating caps on sample tablet vials. Electrical diagram *(b)* shows some of the control circuits used.

was too large in capacity, and hence would be more expensive than the requirements warranted.

▶ Operational Details

Mechanical, electrical, and pneumatic details of the "home-grown" vial filler and capper are diagrammed in *Fig.* 2. Vial holders, mounted at spaced intervals on an endless flight conveyor, *Fig.* 2(*a*), are indexed by a Geneva mechanism. Each holder contains two bushings that form receptacles for vials. Vials in a variety of sizes up to ¾-inch in diameter and 3-inches long can be accommodated by changing the bushings.

When a vial holder is in a horizontal position at the input end of the machine, a pair of vial-inserting blades is advanced on an arm driven by a cam on the main machine driveshaft. The vial-inserting blades then pick up two vials from feed tracks associated with vial magazines on either side of the machine and place them in the receptacles in the vial holder. This action occurs during the dwell period between machine indexes. A mechanical "break-away" feature of the arm prevents crushing of vials that do not seat properly in the holders.

When the arm carrying the vial-inserting blades is in its fully advanced position it actuates an air valve, *V*1, to admit air to nozzles attached to the blades. The function of this arrangement is to blow dust and lint from the vials after they are seated in the holders.

The holders next index to a position such that the vials can receive a predetermined number of tablets from a pair of tablet feed tracks. A detecting circuit insures that a tablet escapement can be actuated to release the tablets only if a vial is present. This action is provided by requiring that vials actuate limit switches *LS*1 and *LS*2 when the holders are in the filling position. Since the limit switches

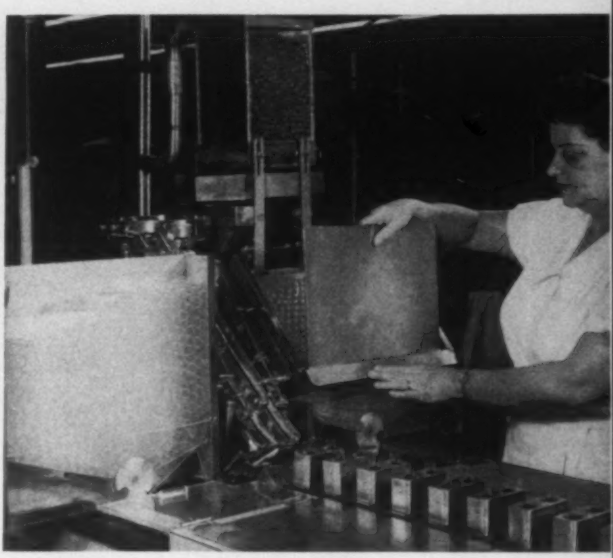
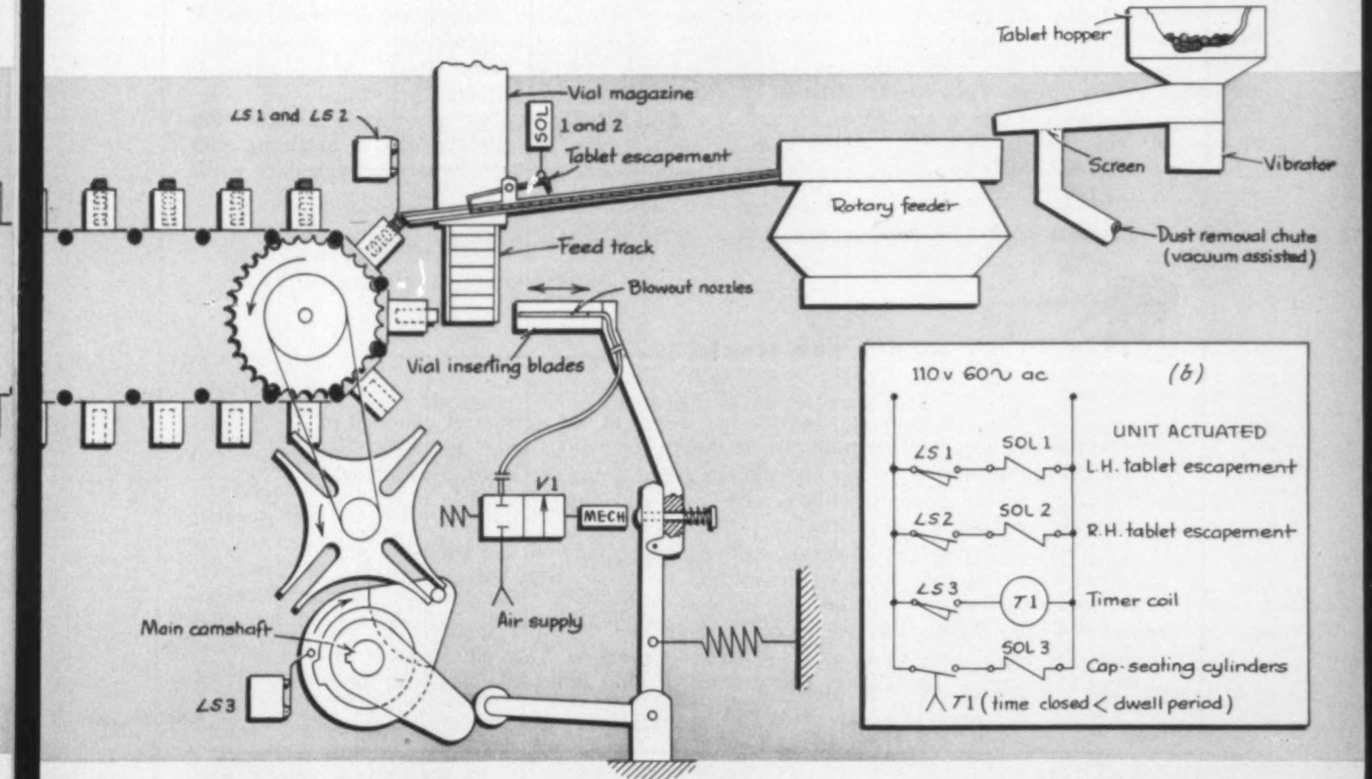


Fig. 3—Vials are loaded into magazines in shipping-carton lots by means of a sheet metal jig. Rotary escapements that supply vials to feed tracks are visible at bottoms of magazines.


Tablet hopper
Vial magazine
LS 1 and LS 2
SOL
1 and 2
Tablet escapement
Rotary feeder
Screen
Vibrator
Feed track
Dust removal chute
(vacuum assisted)
Blowout nozzles
Vial inserting blades
V1
MECH
Air supply
Main camshaft
LS3
110 v 60∿ ac
(b)
UNIT ACTUATED
LS 1
SOL 1
L.H. tablet escapement
LS 2
SOL 2
R.H. tablet escapement
LS 3
T1
Timer coil
SOL 3
Cap-seating cylinders
T1 (time closed < dwell period)

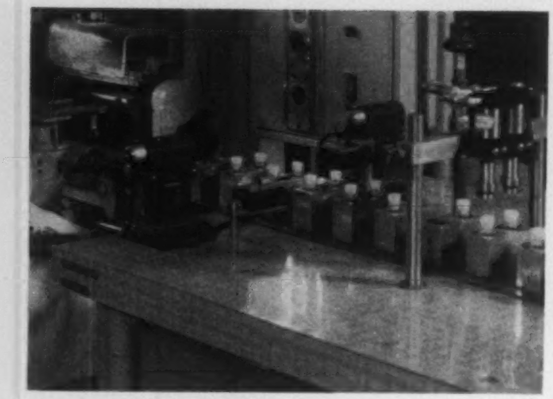


Fig. 4—View of exit end of machine shows cap-seating mechanism, right. Pneumatic cylinders actuate pistons that have spring-loaded heads to limit seating forces. Electric counters, left, register number of vials reaching exit point.

are in separate circuits, *Fig.* 2(*b*), and actuate the feed escapements for each track independently through solenoids *SOL*1 and 2, a single vial in a holder can be filled and the empty receptacle in the holder will not receive tablets.

A blade that projects between the exposed open ends of the vials in the filling position oscillates between them to shake the vials gently. This action serves to settle the tablets so that they lie flat in the vials.

One of the features of the machine is that vials can be loaded into the vial magazines in standard shipping-carton lots, *Fig.* 3. This is accomplished by removing the transparent plastic magazine covers, inserting the vials by means of a sheet metal jig, and tipping the magazine backward on hinges to align the ends of the vials.

Tablets are fed from a hopper to the feed tracks by a vibratory feeder and a rotary feeder connected in tandem. Before dropping from the vibratory feeder into the bowl of the rotary feeder the tablets are passed over a screen. The natural vibration of the feeder, assisted by vacuum applied to the underside of the screen, removes tablet dust.

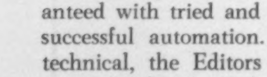
Subsequent indexing of the machine carries the holders past manual loading stations. There, operators seated on opposite sides of the machine visually inspect the vials for proper fill and condition, and place plastic caps loosely in the tops of the vials.

At one of the positions following the inspection and cap-placing operation the vials are stopped under a cap-seating mechanism, *Fig.* 4. This device employs two air cylinders. When a vial holder is in its dwell period under the seating mechanism a limit switch, *LS*3, is closed by a cam on the main machine driveshaft. This switch starts a timer, *T*1, that actuates solenoid *SOL*3 of directional control valve *V*2 to admit air to the cylinders. The resulting downward motion of the pistons seats the caps firmly on the vials.

The period of timer *T*1 is shorter than that of the dwell period of the machine so that the cap-seating cylinders will retract before the next indexing motion occurs. Spring-loaded heads on the ends of the pistons limit the forces that can be exerted on the caps.

After the caps are seated the vials are delivered to the exit point of the machine where they are collected by a labeler operator. At a machine rate of 25 indexes per minute, 50 filled and capped vials per minute are made available to this operator. Production rate of the filling and capping machine could be stepped up and a second labeler supplied, except for the need for careful inspection of products of this nature. As explained previously, the filling and capping machine operators perform an inspection function also, which cannot safely be speeded.

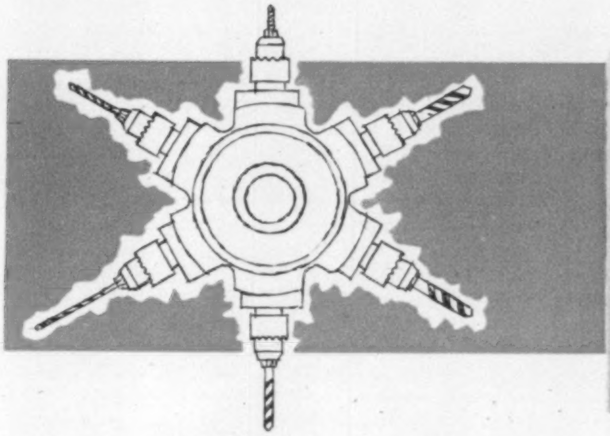
This installation illustrates that in-plant development is often an effective way of obtaining automatic production facilities tailored to specific needs.



are you stuck?

In the past few years AUTOMATION has helped in the solution of hundreds of widely diversified practical problems in making operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available or suitable techniques are known.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, the Editors will be pleased to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this service. Write to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio.



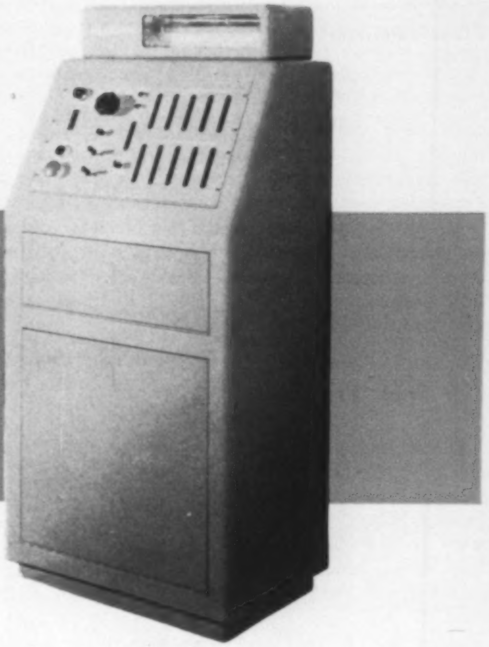


Fig. 1—Compact size of the Electropoint numerical positioning control manufactured by Electrosystems Inc. allows it to be used in close proximity to a variety of machine tools. Preparation of 10 inch wide Mylar plastic tape for the unit is relatively simple, and no computer, code book, or conversion tables are necessary.

NUMERICAL POSITIONING CONTROL

FOR SMALL-LOT MACHINE TOOLS

Numerical control has been an important factor in increasing output from machine tools and in making small-lot production economical. Depending upon the application, the numerical control system can be designed to control a single spindle on one machine or an entire machine tool line. A point-to-point positioning control system for drill presses and similar machine tools is described in this article.

NUMERICAL CONTROL for machine tools has become widely accepted as a means of producing small lots of a complex product economically. Almost as widely accepted is the impression that numerical control systems are quite expensive, employ extensive electronic control systems, and are largely out of the range of the limited capital investment of small manufacturers. This fallacy is far from correct for there are many numerical control systems on the market that will perform adequately for a reasonable outlay of capital. One such system is the Electropoint numerical point-to-point positioning control system manufactured by Electrosystems Inc. This all digital system employing absolute noncounting position measurement is available for accurate control of a variety of machine tools. The Electropoint control unit is small enough to be contained in a floor-mounted cabinet slightly larger than an ordinary filing cabinet, *Fig.* 1.

An interesting application of the positioning control system is available as a control unit for Burgmaster six and eight-spindle drill presses manufactured by Burg Tool Mfg. Co., *Fig.* 2. The machine tool combination is particularly suited for handling small-lot production and consists of a turret-type drill press, an automatic positioning table, and the Electrosystems tape-controlled positioning unit. Programmed on Mylar plastic tape, the positioning unit automatically cycles operation sequences consisting of work positioning, tool selection, cutting speed and feed rates of tools, and similar functions. Setups are fast and easy because of simple controls. Once the combination is set up, it will perform a complex cycle of drilling, tapping, and reaming accurately and quickly, *Fig.* 3.

Tape Preparation

Tape preparation for the control unit is relatively simple, and no computer, code book, or conversion tables are necessary. Decimal information from a blueprint, table of dimensions, or a prototype part is punched into 10-inch wide Mylar plastic tape in two rows of binary coded decimal data—about one-half of the first row designates the X position of the table and one-half of the second row locates the *Y* position. The remaining width of the tape in the two rows provides space for programming up to six auxiliary functions or actions to occur at each *X-Y* position. Since the two-row field is read at one time, up to six drilling sequences can be programmed at each *X-Y* position without requiring tape advance. This decreases tape preparation time and tape length. Tape punching is accomplished by using a hand punch inserted into a template. Each of the X and *Y* rows has five separate decade groupings so that each digit of a five-decimal dimension has its own location. Also available for tape programming is 1-inch wide, 8-channel punched tape prepared by a manual keyboard, similar to that of a calculating machine, which punches the tape automatically and prints a record when a particular set of keys is depressed. This accessory is particularly important when a great quantity of tapes are needed as in a large machine shop, or as in a prototype shop running a large number of jobs.

Operational sequence of the machine tool system is as follows. After the system power is turned on, the prepared tape is installed into the tape reader and advanced manually to the start position. A *Ready* light indicates the system is ready to accept a semiautomatic or automatic cycle. A dial on the control panel is switched to *Auto* position for automatic operation. When the *Start* button is pushed, the tape advances to the first position and stops. The tape reader simultaneously scans the programmed X and *Y* position of the table and the programmed drill turret sequence.

The X and *Y* table position data read from the tape are fed to comparison units which control servomotors for the positioning of the table along each axis. When the table reaches the correct position, table clamping is automatically initiated, and the first drilling, tapping, or reaming operation starts. Any further operations at this position by the multi-

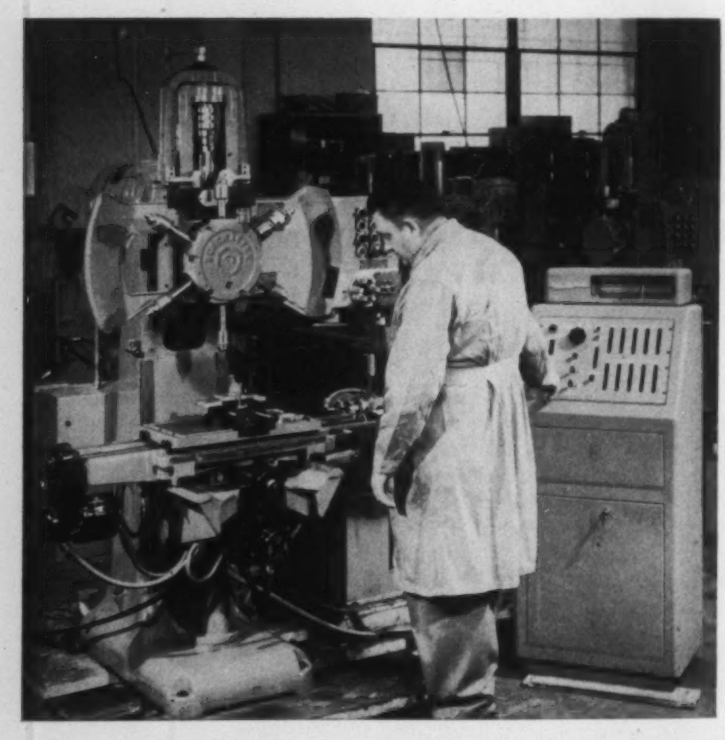


Fig. 2—Electropoint positioning control system is shown installed on a six-spindle, turret-type drill press manufactured by Burg Tool Mfg. Co. Unit is set up to drill laminated insulator parts. Operation was programmed in two hours, tape was punched in 4½ hours, and 204 drilling operations were performed on parts in thirty minutes. Simple vise to hold part eliminated an expensive fixture that would have cost approximately $1800.

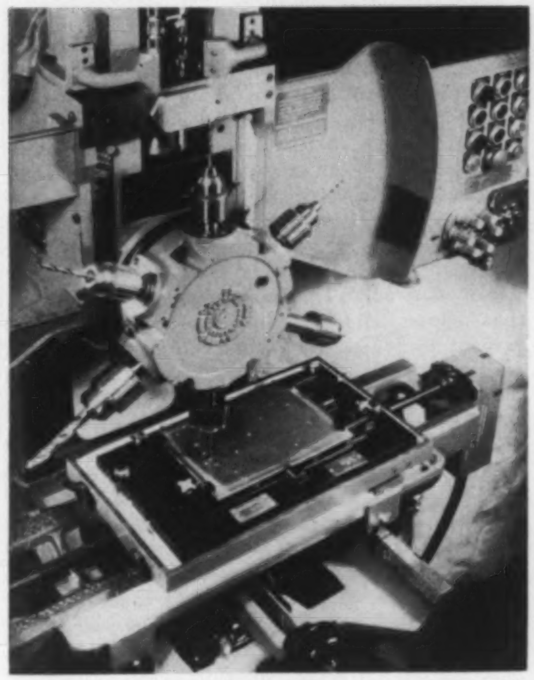


Fig. 3—In another operation utilizing the numerical positioning control system, an instrument base required 21 holes utilizing six different tools in the turret. Setup time, including tape preparation, was approximately two hours. The part was held in a simple fixture eliminating the use of drill bushings to maintain tolerances. Hole centers were maintained to plus or minus 0.001 inch and machining time per part was four minutes, floor-to-floor.

tooled turret are then performed in sequence as punched on the tape. After the final tool operations at this position, the tape advances to the next position where another operating cycle is initiated. When all operations have been accomplished on the part, a *Stop* command punched as part of a sequence command holds the system at the final position for unloading of the part.

When the machine tool is operated semiautomatically, a *Tape Advance* button on the control panel must be pushed to advance the tape to the next command, and a *Sequence Advance* button pushed for spindle operation. This feature is useful in checking individual operations while still maintaining the advantages of a taped program.

▶ Micrometer Display

The control panel displays at all times the exact position of the table in relation to both X and Y axes. For each of the five digits in the decimal number corresponding to the X and Y positions, there is a row of ten pilot lights with numbers 0 to 9. Individual lamps in each of the rows are wired to commutator segments. During table movement these are wiped by brushes to illuminate the lamps in accordance with the table position. This allows the display to be used as an electronic micrometer and permits the following operations:

1. The machine table can be positioned by driving it with either the *X-axis* or *Y-axis* motor switch on the control panel and watching for the desired decimal setting on the X and Y numerical displays. Auxiliary handwheels can also be used to position the table manually.

2. Information for preparation of a control tape can be accumulated by using the display as an electronic micrometer. In operation, the table is moved manually until the correct spindle is located in the hole of the prototype, whereupon the X and Y position from the display is recorded by the operator.

3. Manual control operations can be accurately interspersed with the taped program.

4. Tape and control system can be checked accurately and easily utilizing the display readout—both before the part is machined and during the operating cycle.

Positioning of the table along each axis is accomplished by servomotor drives whose speeds are controlled by the positional error at each particular instant. Flexibility is designed into the Electropoint system for future additions such as tool depth control so the same tool station may be used to produce holes of various depths.

▶ Industrial Applications

Performance of this control system has been demonstrated for over two years in several machine shops under actual working conditions. In a Los Angeles shop the unit controlling a Burg Tool Mfg. Co. turret drill press, produced 200 pieces of special work with a floor-to-floor time savings of 50 per cent. The part produced was an aluminum alloy gear housing requiring tolerances of plus or minus 0.001 inch. Tooling time from blueprint stage was under two hours. Programming the control unit took slightly over one hour, and tape preparation required another fifteen minutes. Runoff time was 3½ minutes per piece. Rework that would normally take up to six weeks was accomplished in approximately five minutes by merely repunching the control tape. Scrap and tool breakage that often occur on small diameter work were virtually eliminated.

In another case, Cannon Electric Co. of Los Angeles made a test run on 0.625 inch thick Formica sheet insulators requiring the drilling of 29 holes in each piece. Where lead time would normally require three to four weeks—with an additional week for runoff—both tooling and production were accomplished within one week. By saving tooling time and eliminating complicated jigs, tooling costs on this project were cut from approximately $730 to $80. In addition, one operator was able to efficiently run three to four machines at one time. Tape preparation in this case was accomplished after less than five minutes of oral instructions.

ELECTRICAL BAKING SPEEDS CARBON BRICK MANUFACTURE

AUTOMATIC manufacture of industrial carbon products has been started at a new plant of National Carbon Co. through the development of a new process for blending, pressing, and electrical baking of carbon mixtures. Under development for several years, the new method reduced manufacturing time for carbon brick from eight weeks to less than eight minutes and opened the door for automating the entire process, *Fig.* 1 and 2.

Prior to the development of the new process, carbon product manufacture was based on using a mixture of carbon flour combined with a binder of tar or pitch. After being heated to slightly less than the melting point of the binder, the mixture was cooled and extruded to a variety of shapes in a press. The uncured material was then packed in a gas-fired furnace and baked for several weeks. Baking by passing an electric current directly through the mix was not feasible with this process since the liquid binder coating on the carbon particles created a high electrical resistance and would have required very high voltages.

Development of the new process has resulted in a method of blending that allows sufficient contact between particles of the mix to lower the electrical resistance and promote the initial flow of current. This is accomplished in a specially designed hydraulic press which simultaneously applies a pressure of several tons per square inch to the mix and acts as a conductor for the electrical baking current. As the press shapes the material, the electrical current melts the binder and forces it uniformly through the mix. The baked material is then ejected automatically from the press into a cooler that reduces its temperature to 480 F or lower to prevent oxidation. Automatic conveyors carry the carbon products to the finished stores area where they are palletized and loaded in railroad cars for shipment.

Heart of the new system is a specially designed hydraulic press that operates at an average pressure of several tons per square inch and at temperatures in the range of 2000 F. The piston of the press conducts current through the carbon mix, and the molds act as an electrical insulator. Depending on the size of the product being made, currents range from 3000 to 100,000 amp. Close control is extremely important since such large currents could bake the carbon almost instantaneously, except for the volatile gases given off as the binder is heated. The electrical baking rate must be held to a point at which these gases escape freely or else the carbon product might explode from the internal gas pressure.

The shortened production cycle allows close quality control since variations in product can be picked up in minutes rather than in weeks required by the old method. The extreme flexibility of the process makes it possible to design and evaluate in a short length of time carbon products with optimum properties covering different specifications. Initially, the new process will be used to produce carbon brick for furnace linings. Later, its use will be extended to a wide variety of carbon products used throughout industry, ranging from small carbon electric motor brushes to large carbon brick.

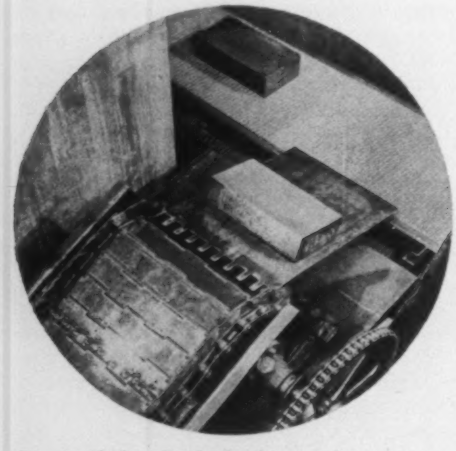


Fig. 1—Carbon bricks for furnace linings are conveyed continuously from hydraulic form-and-bake presses at National Carbon Co. The automated production process requires less than eight minutes per brick as compared with nearly eight weeks by previous methods.

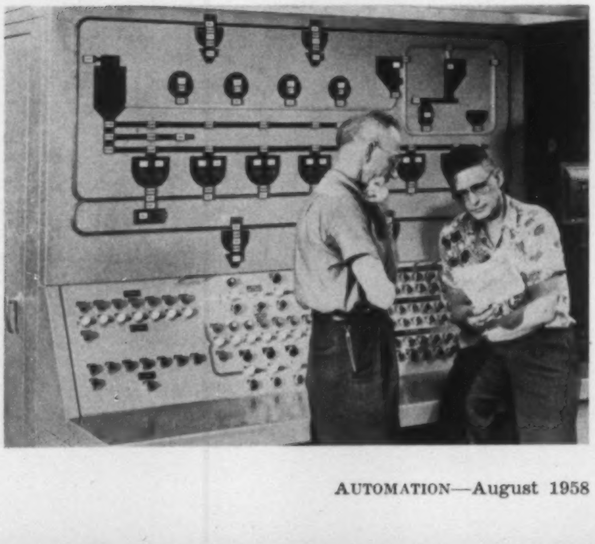


Fig. 2—Master control panel sequences the manufacturing operations automatically according to predetermined settings. Each section of the panel represents a stage in the new process for forming and baking carbon bricks.

Knowledge of types of infrared heat sources, oven design factors, and radiation principles will assist designers and users in profitably employing infrared heating equipment. Of special interest are the accurate control of temperature and versatility of application possible with this heating medium.

INFRARED RADIANT HEATING

IMPROVES MANUFACTURING PROCESSES

By **PAUL H. KRUPP**, Fostoria Pressed Steel Corp., Fostoria, Ohio

REQUIREMENTS for faster and better methods of producing industrial and commercial products that started in earnest during World War II remain, and today there is a greater demand than ever for automated production facilities. Many processes, tools, and equipment items are adaptable to automatic production lines to speed them up, improve product quality, save time, save space, or reduce over-all costs. Infrared radiant heating is one such process that makes automation practical on many lines where accurately controlled heating is required.

Although infrared was applied by the Ford Motor Co. as early as 1939 for production purposes, it is still regarded as a comparatively new industrial heating method. However, equipment has continually been improved in the interim so that today most segments of industry can profitably employ it in heating applications. With well-designed equipment installed in well-designed ovens, infrared can be depended on to produce results that are equal or superior to those attainable with other heating methods.

Because of the wide applicability of this heating medium, there is a general need for an accurate and clear understanding of the infrared process and its capabilities.

In an infrared oven, heat is transferred from the source to the product by direct and reflected radiation. It is vital that the reflectors used be specular and that their metal surfaces offer the highest possible reflectance for infrared. Gold is generally accepted as the most practical metal for the purpose, and offers the highest reflectance for infrared. The gold is usually applied by electrolytic processes over coatings of bright nickel and copper on a base form of steel. In most applications it is important

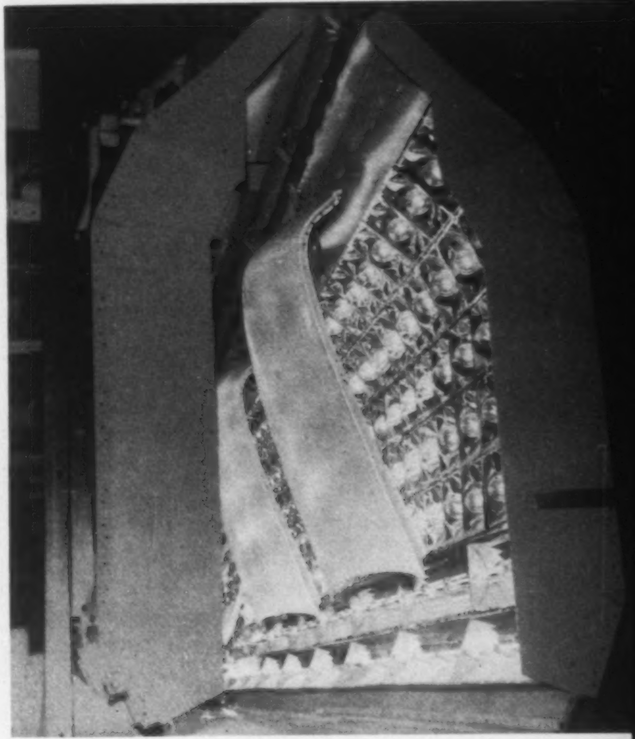


Fig. 1—Infrared oven in a continuous painting line at Ford Motor Co. dries various metal parts before they are painted. Drying is accomplished in approximately 3 minutes. Quartz lamps are used in the two lower rows of the oven because they will not break if water drips on them during the drying operation. Upper rows are of the glass lamp type.

TABLE 1—Characteristics of Major Types of Infrared Heat Sources

Characteristic	Quartz Lamp	Glass Lamp	Quartz Tube	Metal Rod
Heat rating[1]	very high	low to medium	low to medium	high
Life[2]	very good	very good	good	very good
Resistance to splashing liquids	very good	low	very good	very good
Resistance to impact	low	low	low	high
Color sensitivity[3]	medium	medium	low	low
Cost per kw rating[4]	high*	low	high	low
Visible light output[5]	high	medium	low	low
Filament temperature	high	high	low	low
Response to heat-up and cool-down command[6]	fast	fast	medium	slow
Efficiency	As source operating temperature is increased, a larger percentage of the input energy is radiated and a smaller percentage is transmitted by convection. To this extent the source having the highest operating temperature is most efficient. From a practical standpoint, however, oven design factors, such as heat loss to the socket and reflectance of the reflectors used, affect over-all efficiency. Also, requirements for other source characteristics may dictate use of a source that is not the most efficient.			
Normal application	lowest operating cost for high heat range	most economical in first cost and operating cost for low to medium heat range	low brightness and very good resistance to splashing liquids in low to medium heat range	where mechanical ruggedness is required; low first cost
Limitations	high first cost	low resistance to splashing liquids	medium heat response; high first cost and operating cost	slow heat response; high operating cost

*in low intensity applications

NOTES

1. Heat rating of a source refers to the amount of heat in watts or BTU/hr that is potentially available. Selection of source is based on the requirements of the product. Serious mismatching of heat capacities and requirements should be avoided.

2. Radiant heat sources are subject to failure as a result of breakage and deterioration in output through continued use. Metal rod types have the highest resistance to breakage by impact. Assuming physical damage is not a factor, life of all radiant heat sources is probably about the same with respect to deterioration with use.

3. Color sensitivity refers to the effects of color on the rate of absorption of heat. The achromatic colors black and white exhibit the highest and lowest heat absorption rates respectively. Considering sources alone, the low brightness far infrared types (quartz tube and metal rod) will heat bodies of different colors at more nearly the same rate than will the high brightness near infrared types (quartz lamp and glass lamp). However, the source is but a part of a complete oven, and the greater color sensitivity of near infrared sources can be partially compensated in the design of the oven. This is discussed in the section describing equipment design factors.

4. The cost of heat sources for an infrared application deserves careful consideration in light of the characteristics required. Glass lamps are satisfactory for most applications and are the lowest priced. Where ruggedness is required, metal rods should be considered if their characteristics are otherwise satisfactory. Similarly, the higher priced quartz type sources may be the economical choice for some applications.

5. Visible light output is a function of the operating temperature of the source. When brightness of the source is not a disadvantage, high temperature sources are often specified because they offer more usable heat in the form of radiation than sources operating at lower temperatures.

6. Many applications require heat sources that have fast build-up to peak operating temperature and rapid cool-down upon de-energization. In continuous paint baking setups, for example, time is saved in starting the line when heat-up response is fast. In the event of deenergization of the oven due to conveyor stoppage, fast cool-down response of the heat sources will avoid damage to the paint finish.

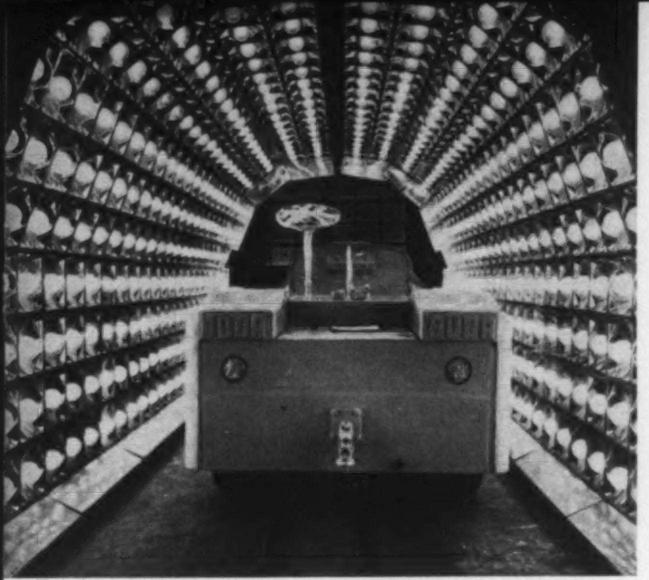


Fig. 2—Glass lamps having a total connected load of 100 kw are used in this paint baking unit. Lift trucks and tractors which have been masked and sprayed move through the tunnel for baking on a 10-minute cycle that is synchronized with the spraying operation.

that the reflecting surfaces be shaped so as to provide uniform distribution of heat. When this is done, it is possible to bathe products uniformly with heat, even though the products may be odd-shaped in all three dimensions.

▶ Infrared Heat Sources

Four major types of infrared heat sources are available for industrial applications:

1. **Quartz Lamps.** These are straight tubes made of fused or clear quartz containing heat filaments of tungsten. The filaments are operated at a temperature of approximately 4000F. Lamps are available in a variety of wattages.

2. **Glass Lamps.** Bulb type units are available in a variety of wattages. Bulbs may be hard or lime glass and filaments are of tungsten operated at approximately 4000F.

3. **Quartz Tubes.** Employing alloyed metal filaments, quartz tubes are similar to quartz lamps but are operated in the temperature range 1400-1800F.

4. **Metal Rods.** Straight rods of nickel alloy or stainless steel contain resistance elements of various metal alloys which are insulated with magnesium oxide. Operating temperatures are 1200-1500F.

All infrared heat sources have certain basic characteristics that may be considered advantages or disadvantages, depending on the application ininvolved. Determination of the proper heat source can only be made after an analysis of the job requirements. TABLE 1 and accompanying notes provide a resume of the important characteristics of the four major types of heat sources.

▶ Oven Control

Standard electrical components and instruments are usually adequate for the control of industrial infrared ovens, and a variety of control functions can be provided through their use. Heat zoning, for example, can be set up wherein different temperatures are maintained throughout the length of the oven and even in its cross section where desired. With heat zoning it is possible to raise product temperatures quickly or gradually as they proceed through the oven. Holding zones can also be established that maintain product temperatures within close limits.

For safety, electrical controls can be included that de-energize the oven heaters in the event the product conveyor is halted, or reduce the heat to a safe level which may correspond to the level in one or more of the holding zones. When applicable, the latter action may serve to protect the product in the oven and thus minimize the penalty of a conveyor shutdown. Various other safety actions can readily be provided with conventional electrical control components.

Automatic operation is also possible through use of interlock arrangements, timers, and controllers. Its use should be investigated in all cases because of the output, efficiency, and product quality advantages inherent in most automatic cycles.

▶ Infrared Applications

A description of some of the production applications for infrared radiant heating equipment will illustrate the adaptability of this medium to a variety of industries and products.

Metalworking. In the metalworking field infrared ovens are used widely for water dryoff, *Fig.* 1, and paint baking, *Fig.* 2. Other applications in-

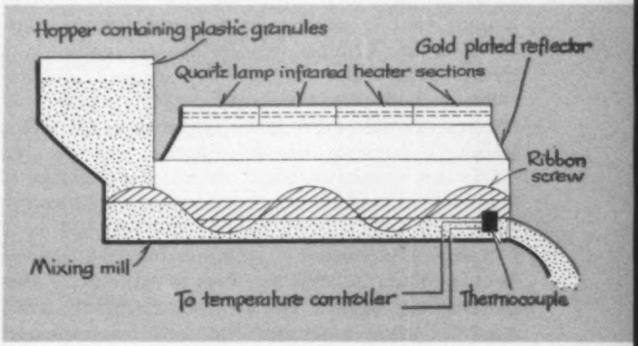

Hopper containing plastic granules
Gold plated reflector
Quartz lamp infrared heater sections
Ribbon screw
Mixing mill
To temperature controller
Thermocouple

Fig. 3—Diagram illustrates a mixing mill for heating polyvinyl plastic granules. Plastic is introduced from a hopper and drops onto a screw conveyor. Heat is applied from above by a quartz lamp infrared heater equipped with reflectors. Thermocouple control maintains uniform heating by cycling the heater between full and half-voltage.

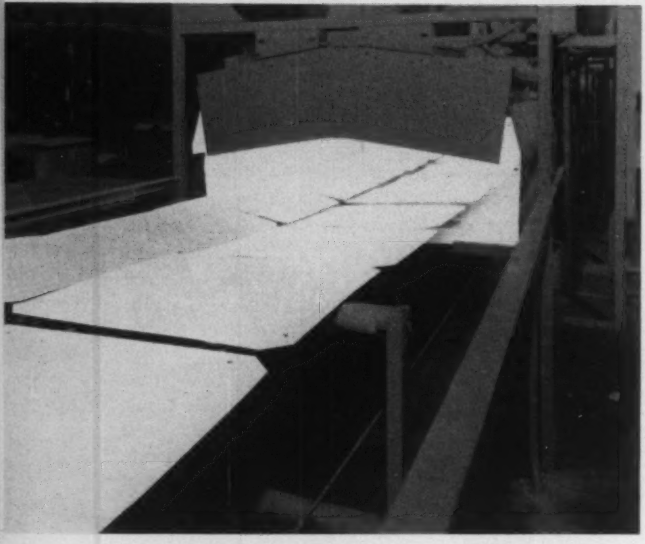


Fig. 4—Infrared oven is a part of a continuous bonding line for dishwasher cabinet tops. Adhesive-sprayed sheets of plastic and metal are carried through the oven and heated. After heating, the sheets are placed with their sprayed surfaces together and bonded by passing them between pinch rolls.

clude use in thermal degreasing, soldering, preheating for shrink fit operations, and frit drying and firing.

Plastics Manufacture. There are many opportunities for applying infrared in plants where plastics items are manufactured. In addition to use on continuous conveyor lines, it is often used in applications calling for intermittent application of heat, as in a portion of a machine cycle. An example of the latter is in the forming of sheet plastic into refrigerator inner doors. In this operation, flat sheets are picked up mechanically from a pile and indexed into position over a forming mold. When a sheet is in the proper position over the mold, infrared radiant heat is applied for a predetermined time. As soon as forming temperature is reached the sheet is drawn into the mold by vacuum. Electrical controls determine the heating cycle, which may range from 30 to 60 seconds. At the end of the heating cycle the infrared equipment may be shut off or its output reduced. Accurate regulation of temperature and timing are possible through electrical control.

Another interesting application in the plastics field pertains to the heating of granules. One plastics manufacturer was confronted with the problem of finding a faster, better and less expensive way of heating plastic material in powder form. Polyvinyl plastic powder had previously been dumped from bags into a mixing mill which included revolving steam-heated rolls. Approximately 5 minutes were required to raise the temperature of the powder to 250F so it could be compacted into a mass.

After considerable study of handling and heating methods it was decided to feed the plastic powder into a mill by hopper and to use infrared heating equipment, *Fig.* 3. The material is heated from above as it is carried across the mill by a screw conveyor.

Quartz lamp equipment is used in this application and electrical controls actuated by a thermocouple mounted on the side of the mill maintain constant powder temperature. Temperature control is effected by cycling the heaters between full and half-voltage.

This installation provides several advantages over previous methods: 1. Maintains continuous production. 2. Provides improved temperature control and hence product quality. 3. Automatic operation reduces labor costs.

Adhesive Bonding. Many products today are made by laminating separate layers of various materials and bonding the layers with adhesives, Building panels, desk tops, doors, and airframe members are made by this process. In the manufacture of such products it is usually necessary to heat the adhesive prior to bonding in order to speed the removal of volatile solvents and to prevent condensation of moisture on the product. Condensation is promoted by the cooling effect of the solvent evaporation process, and must be avoided in order to provide a strong bond. This is especially important in the manufacture of building panels.

An infrared oven which is a part of a continuous bonding line is shown in *Fig.* 4. Installed in the Louisville, Ky. plant of General Electric Co., the setup is used to bond plastic and steel sheets in the manufacture of tops for dishwasher cabinets.

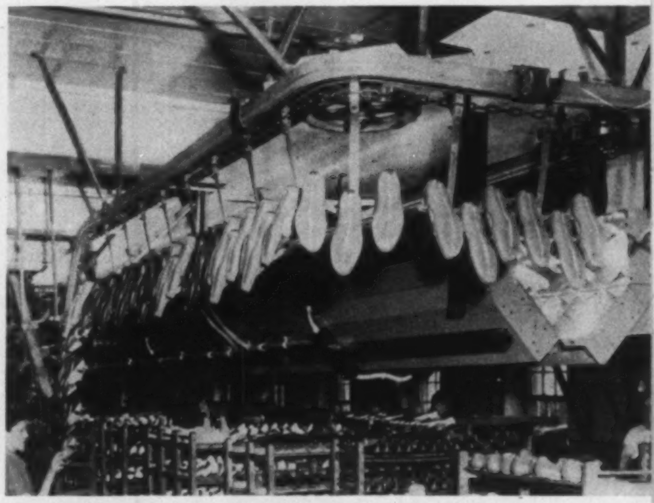


Fig. 5—Moccasins which have been soaked in water to soften the leather and enable it to shrink to the last are dried in a conveyorized infrared oven. Proper drying is accomplished through use of 500 watt lamps to heat the soles and 250 watt and 375 watt lamps on the other side to heat the lasts.

Design Factors for Infrared Heating Equipment

Infrared heating equipment is commonly made up of basic units, or sections, that contain radiant heat sources. These basic units, and the complete ovens employing them, must be designed with several important considerations in view. In particular, life, efficiency, and color sensitivity are affected by section and oven design. Some of the more important design and selection criteria are:

Radiant Reflectivity. This term has become generally accepted as descriptive of the reflectance of the metal reflector which is used to collect and direct infrared energy to the product. Reflectance may be defined as the percentage of radiation that is reflected from a surface with respect to the total radiation reaching it. It is a function of the material of a reflector, and may vary from 98 per cent for specular gold coatings to 50 per cent for aluminum paint coatings on steel. Obviously, the higher the radiant reflectivity of the reflectors the more efficient will be the oven, and less heat will escape through the oven walls. In many cases use of highly reflective surfaces eliminates the need for insulation.

Reflector Contour. The shape of a reflector and the position of the heat source in relation to it determines the pattern of heat distribution to the product. In most cases the specifications for radiant ovens call for wide, even heat distribution to the work, although nonuniform patterns are readily provided when required.

Oven. To get a desired heating effect it is necessary to design an oven of the proper shape and size. This is usually accomplished by literally wrapping a sufficient number of sections around the product to envelop it in radiant heat. The oven enclosure is fitted with suitable reflectors. Products of a wide variety of shapes and sizes can be efficiently heated with ovens built in this manner.

Ventilation. All radiant ovens require ventilation to some degree. Both natural and forced ventilation systems are used. Whatever the type, the purpose of ventilation is twofold: 1. Applied to the oven shell, it protects sockets, wiring, and other components against overheating. 2. Ventilation of the interior of the oven removes smoke, fumes, moisture, and solvents which may be dangerous or detrimental to the product. Adequate ventilation of an infrared oven thus assures long component life and safeguards the quality of the product.

Flexibility of Use. It is not uncommon in industry for processes to change and alter oven requirements. Also, it is often desired to run more than one size of product or a variety of products having different heating rates on the same equipment. Additional oven length, more heat in the same length, and even different types of heat sources may be needed as a result. In such cases the oven that can be controlled, or altered readily at reasonable cost, is often the economical choice in spite of higher initial cost.

Color Sensitivity. The higher the radiant reflectivity of an oven, the lower is its color sensitivity. This may be explained as follows: In a well-designed oven very little energy is lost. The infrared rays, traveling at the speed of light, either strike the product on their first pass from the heat source or on successive passes as they are reflected from the oven walls. There is thus available for heating the product nearly all of the radiant energy developed, and differences in heating rates due to color are reduced.

From the foregoing it is clear that there are many factors to consider in the design and construction of radiant heating equipment. The value of a particular installation depends greatly on the presence or absence of the many available features of control and design in light of the requirements. The top quality oven with the higher price may be the most economical in the long run. On the other hand there may be considerations even more important than first cost that dictate investment in lower cost equipment.

Both sheets are sprayed on one side with adhesive and are moved through the oven on the conveyor. Heating to approximately 200F is accomplished in 1 minute. After leaving the oven the sheets are bonded by pinch rolls.

Shoe Manufacture. The past practice of air-drying shoes to remove moisture and adhesive solvents is giving way to conveyorized infrared drying lines in many shoe factories. A setup for drying moccasins is shown in *Fig.* 5. An operator removes wet moccasins from racks and places them on the oven conveyor. After they have passed through the oven they are returned by the conveyor and the same operator replaces them in the racks. Time in the oven is 18 minutes; by air-drying methods the time would be a day or more.

In another shoe factory application the bottoms of men's leather shoes are dried prior to final finishing and packing. The operation is continuous and drying time is 5 minutes by infrared heating. A previous method employing a convection oven required 90 minutes.

In the production of certain types of shoes, manufacturers have found it possible to perform all of the work operations, including infrared heat processing, along a continuous conveyor line.

Food Processing. The food processing industry employs a great many infrared installations in conjunction with automated production lines. The close control of heat possible with infrared is one of the compelling reasons for its adoption in this field. Time and space savings are also obtainable in many cases through its use. *Fig.* 6 illustrates an infrared oven installation that is used to dry cookies before packing. The oven is 18 feet long, and replaces a previous oven that had the same drying capacity but which was 100 feet long.

Noodles, dog food, and puffed corn products are also dried by the infrared process. Browning and partial cooking of meat before it is frozen, and cooking of yams for packing and freezing, are other common applications.

Textile Belting. Drying impregnation in textile

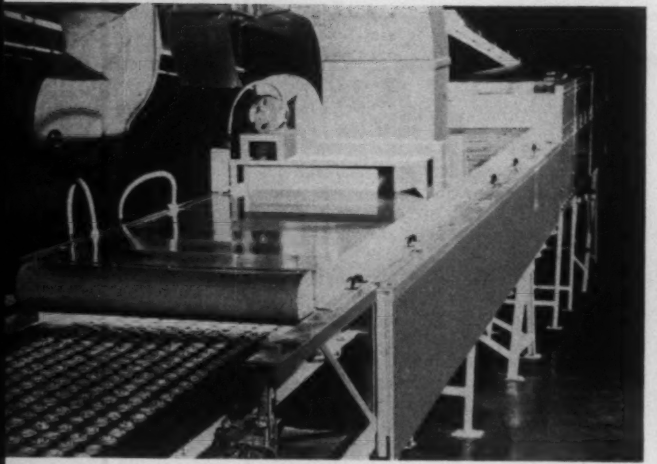
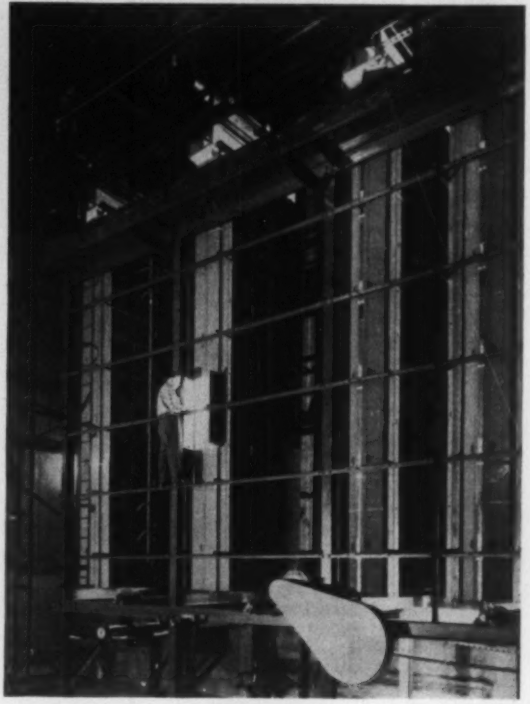


Fig. 6—Cookie drying oven is 18 feet long and employs infrared heaters. It replaces a 100 foot long oven of the same drying capacity.

Fig. 7—Four vertical infrared ovens are used to dry impregnation in textile belting. Heat from glass lamp infrared heaters can be controlled to accommodate a variety of belt materials and impregnating compounds.



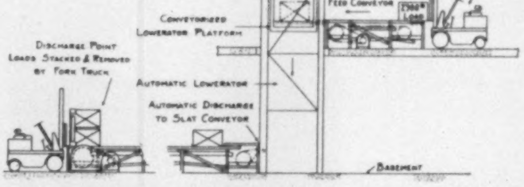
belting is accomplished at Globe Woven Belting Co. on four 22-foot vertical ovens, *Fig.* 7. The ovens employ glass lamp type infrared heat sources, and heat can be varied throughout the oven to accommodate a variety of belt materials and impregnations.

Generally speaking, wherever accurately controlled heat is needed, infrared may be the answer. The extent to which it can be applied to effect lower cost automated production depends to a large extent on the imagination of the manufacturing enginer who sets up the line and on the designer who conceives the various machines for the line.

conveyor system cuts handling time

HANDLING time for bulky tinplate bundles weighing as much as 2500 pounds has been cut 66 per cent at a large eastern canmaking plant with a new interfloor conveying system developed by Gifford-Wood Co. The completely automatic system consists of slat-type, horizontal feed and discharge conveyors on each floor connected by a vertical elevator operating in a shaft. Interlocking electrical safety switches at each transfer step work in conjunction with photoelectric units to insure safe movement of material from floor to floor.

The entire system is set in motion when a load is removed from the discharge conveyor on the upper level. This action breaks a photoelectric beam and automatically allows another tinplate bundle to move to the discharge point of the upper conveyor. At the same time, the vertical elevator unloads a bundle onto the discharge conveyor and automatically returns to the lower level for another load. The lower level feed conveyor then releases a load onto the elevator platform and allows the following bundle to move into position next to the shaft. The cycle is completed when the elevator automatically returns to the upper level and holds the bundle until the discharge conveyor is again unloaded.


Load placed on Feed Conveyor by Fork Truck
Feed Conveyor
2500# Load
Conveyorized Lowerator Platform
Discharge Point Loads Stacked & Removed by Fork Truck
Automatic Lowerator
Automatic Discharge to Slat Conveyor
Basement

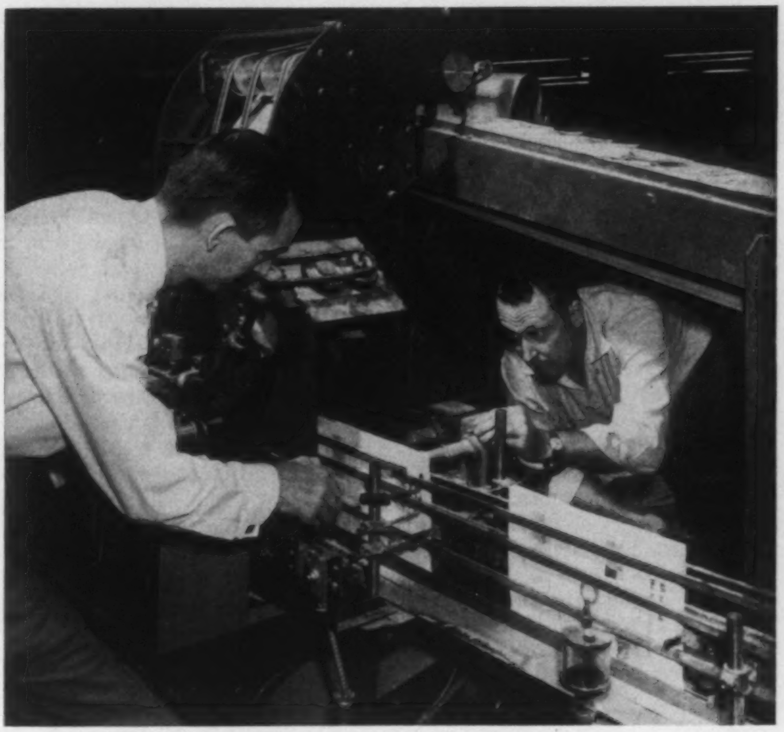


Fig. 1—Close-up of detector/-ejector system installed on binding machine for side-stitched magazines. Photoelectric cells gage lengths of gathered pages, or books, and signal ejector mechanism to remove books that have horizontally misaligned pages. Vertical tape conveyor, center, deposits ejected books on chute at top of machine.

PHOTOCELL LENGTH DETECTOR

REJECTS IN-PROCESS DEFECTIVES

PRODUCTION problems encountered in specialized fields are often basic to a large number of manufacturing endeavors, and their solutions are of interest to others. For example, a problem experienced in the publishing of books and magazines—the detection and removal of defective work-in-process before unnecessary time, effort, and materials are expended—is certainly found in other industries. This problem has recently been solved by the engineers of Meredith Publishing Co. in a phase of the binding process for side-stitched magazines, *Fig.* 1.

The first step in the assembly of a side-stitched magazine is the gathering, in the proper order, of individual signatures (printed sheets that are folded into four, or a multiple of four, pages), gatefolds, and/or inserts. This is performed in the gatherer section of a binder. There, pickup pins attached at intervals to an endless chain are carried past a series of pockets, or loading stations, where signatures, gatefolds, and inserts are successively dropped in position between the pins as required. Thus, a stack of pages in collated book form is accumulated by each pickup pin.

The pickup pins proceed through the gatherer section in a nearly vertical position and, by a twist in the endless chain, become horizontally oriented at the exit end of this section of the binder. At the same time the stacks of pages, or books, are turned by guides until they are in a vertical position with their folded edges down. It is in this position that they are conveyed through the wire stitching, gluing, and covering sections of the binder.

▸ The Problem

It is essential that the individual sheets comprising each book be aligned prior to the wire stitching operation. To accomplish this, the gathered books are passed over jogging rollers which align the individual sheets so that their trailing vertical edges contact the pickup pins, and their bottom edges are even.

Because most Meredith publications contain a good number of gatefolds, inserts, and half-pages, thereby making alignment more difficult than for books composed solely of signatures, about 1 per cent of the books come through the jogging rollers with their sheets out of alignment. It was to avoid the subsequent stitching, gluing, covering, and disassembly of some 720,000 such defective books annually that development of an automatic detector/ejector system was undertaken. Since detection and ejection of books that are misaligned in the horizontal direction is an operating reality, the equipment for this phase of the problem, *Fig.* 2, can be described.

▶ Detecting and Ejecting

After jogging, the books are carried by the pickup pins past a series of three spaced photoelectric detector units. These units, which employ cadmium sulphide cells, are set to detect the interruption of light beams that cut perpendicularly across the line of travel of the books. The space between detector units *A* and *B* corresponds to the maximum length of correctly jogged books. Because variations up to ⅛-inch may occur in the lengths of the sheets, projections of less than this amount are not detected.

Detector unit *C* is placed four inches upstream of *B*. Its function is to detect the presence of a space between books and thus differentiate between blocking of the light beams for detector units *A* and *B* by a single misaligned book, or by two separate books. Its inclusion was necessitated by the fact that the distance between successive books is less than the length of the books. The three detector units are interconnected so that the only time a corrective signal is generated is when the light beams for units *A* and *B* are blocked and that for unit *C* is uninterrupted.

Signals indicative of horizontally misaligned books are fed to an automatic ejector mechanism. This device includes two pairs of rollers mounted immediately behind the length detecting units, one on each side of the path of travel of the books. One of the pairs of rollers is mounted on a rotating shaft section that is laterally movable by virtue of a double universal joint connection to its driveshaft. The other pair of rollers is mounted on a shaft that rotates in fixed bearings.

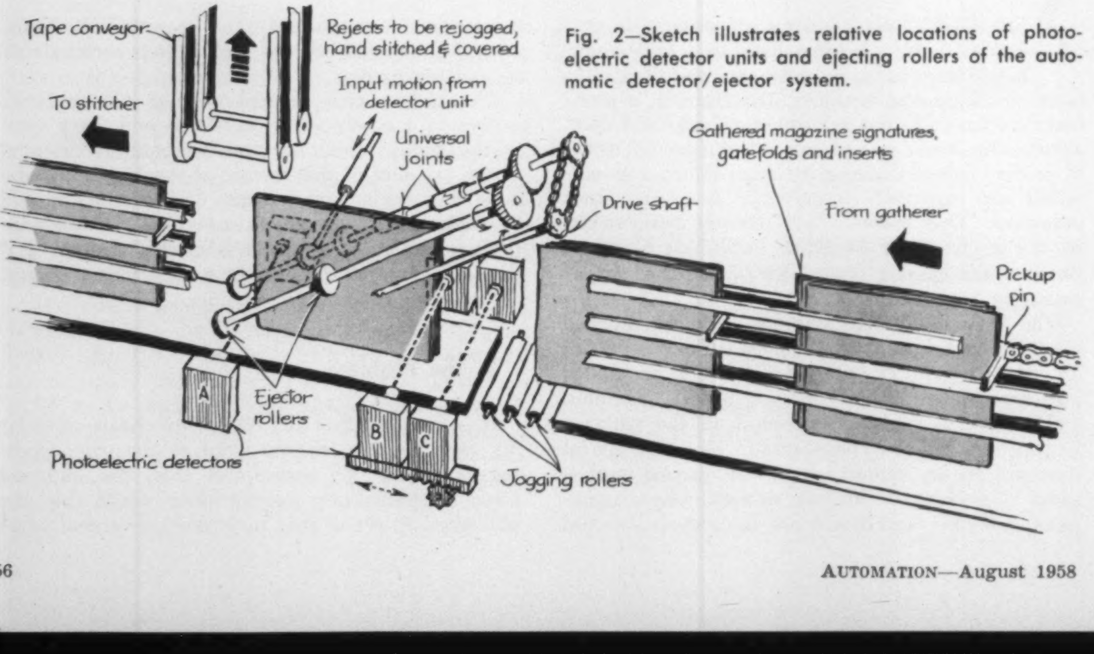
When the ejector mechanism is not actuated, the lateral space between the two opposed sets of rollers is such that books can pass freely between them on their way to the stitcher. When an impulse is received from the detector, however, the movable shaft section of the ejector mechanism is advanced toward the defective book so that it is pinched between them. Because of the angle at which the rollers are mounted, and their directions of rotation, books pinched between them are carried forward and lifted. This action presents the books to the receiving end of a conventional tape conveyor which deposits them on a chute at the top of the machine. Such books, called refolds, are later collected for rejogging, hand stitching, and covering.

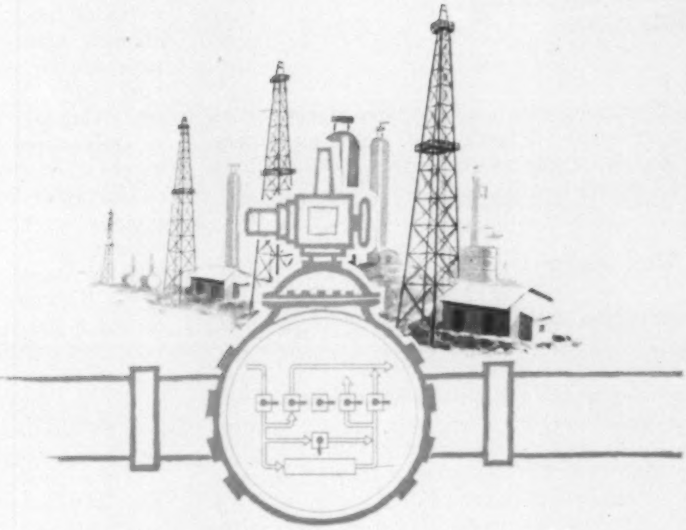
At the normal production rate of 120 books per minute the entire process of detecting, ejecting, and returning of the ejector mechanism to a state of readiness for the next book must be accomplished in less than ½ second. This is the time interval in which successive books are presented to the detector for inspection of alignment.

To accommodate books which vary in nominal length, the two upstream detector units can be moved longitudinally back and forth on a common rack. Thickness variations are taken care of by adjusting the in-travel of the movable roller shaft.

Although the system was designed specifically for side-stitched magazines, the same principles are applicable for publications of other types of construction. Some of the principles employed may also find use in the solution of production problems in a variety of industries.

Fig. 2—Sketch illustrates relative locations of photoelectric detector units and ejecting rollers of the automatic detector/ejector system.





AUTOMATIC TECHNIQUES OF OIL AND GAS PRODUCTION

Step by step, the petroleum industry is developing automatic equipment to solve production problems that are both unique and formidable. Here the author highlights equipment and techniques of the automation of oil and gas production.

By NEWTON E. ARMSTRONG, Manager, Control Div., Southwestern Industrial Electronics Co., Houston, Tex.

THE PETROLEUM industry, like other industries, is irregular in its use of the term "automation." The term is variously utilized to mean simple, powered operation of otherwise manual devices; pushbutton-type remote control; remote monitoring of operations; electronic data processing; continuous, unmanned instrumentation; automatic cycling; and simple or complex closed-loop control. In general, then, in the petroleum industry, automation has come to mean any change which tends to make the mode of operation more automatic. Automation of oil and gas production and transmission is specifically concerned with well control, well-test, custody transfer, valve setting, and pump and compressor station operation.

An appreciation of the various degrees of automation in use and currently being installed in the oil and gas industries can be obtained by reviewing a variety of systems of increasing complexity.

The simplest process involving automation in the oil industry occurs during custody transfer. In a given lease or field, large storage tanks are usually used to store petroleum produced in the lease, and to provide a source of flow in a steady stream into a pipeline. These tanks are also often used as a metering device, in the manner of a measuring cup. Floats, sonic depth devices, optical depth meters, beta-ray depth gages, and resistance-type interface detecting devices may be located in these tanks, and used to determine the degree of fullness of a given tank. Signals from these sensing elements may be transmitted to an instrument shack to provide central indication of the state of the tanks in a "battery."

On-off type devices can be used to detect full and empty status of tanks. These can be connected to switching units—pneumatic, electromechanical, or electronic—and these in turn connected to inlet and outlet valve actuators on the tanks. Such an arrangement can automatically direct a desired sequence of filling tanks from the wells, and emptying the tanks into the pipeline. By connecting some type of counting unit to appropriate valve actuators, the quantity of oil flowing into the tank battery, and into the pipeline during a given period of time, can be recorded automatically.

▶ Well Testing

Another example of automation is to be found in the unmanned control and recording of well testing. The major operations in automatic well-test are as follows: At a certain time flow from the well to be tested is begun, either by opening a wellhead valve, or by starting a pump or gas lift system. A short time later the fluid from the well is diverted from a production manifold to a test manifold. These manifolds are systems of pipes and valves, located at points central to a small group of wells. They are so arranged that the flow lines from each well may be connected either to a production processing unit or a test processing unit by operation of pneumatic or electrical valves.

The test manifold leads to a separator where water, oil, and gas are separated and fed into three different pipes. Flow through the water and oil pipes can be measured by turbine or paddle-wheel type meters, by dump meters, or by magnetic meters. Gas flow may be measured by paddle-wheel or turbine-type meters or by an orifice flow computer.

The orifice flow computers utilize the differential pressure across a constriction in the pipe, together with the static flow pressure, temperature, and specific gravity of the gas to compute the rate of gas flow. This rate of flow is time-integrated to produce a measure of accumulated flow.

In automatic well-test, as the flow from a well under test is diverted to a test manifold electrical pulses are produced by the oil and water meters and by the magnetic integrator associated with the gas flow computer. These pulses are each representative of a certain quantity of flow. Each of the three pulse trains is stored in a separate electronic storage register.

At the end of a given test period, flow from the well under test is diverted from the test manifold to the production manifold. The electronic storage registers are electrically disconnected from the flow meters and gas flow computer and the numbers

ENVIRONMENT OF OIL AND GAS AUTOMATION

IN the oil and gas industry, "production" refers to the processes directly associated with getting the crude oil and gas to the surface of the earth. "Transmission" or "transportation" refers to the movement of these fluids and their products from one point to another through pipes. As oil and gas are commonly found in close association with each other in the natural state, oil production and gas production are normally inseparable. Likewise, production and transportation, particularly of natural gas, are often treated as portions of a single over-all operation.

The natural hydrocarbon mixtures found in the ground are usually under pressure exceeding atmospheric. This pressure may be caused by the occurrence of the gas in a compressed state or by hydrostatic force, or both. In some newly exploited fields, and in partially depleted fields, the pressure exerted on the oil and gas is insufficient to force the fluids to the surface. Under such circumstances it is necessary to use artificial means to cause flow to the surface. These means may be pumps or "gas lift".

Gas lift is a pumping style action in which gas under high pressure is forced down the well intermittently. These intermittent "slugs" of gas rise to the surface of the well due to their buoyancy, and carry petroleum with them. Also in old fields, oil in the main pockets may become depleted, while large quantities may remain in interstices in the porous rocks in other areas in the formation. It is common practice under such circumstances to force water into the oil strata at points where the strata are deeper in the earth than they are at the producing wells. This re-establishes hydrostatic pressure and forces the imbedded petroleum to move into the pockets from which it is produced.

If oil is withdrawn from a field too rapidly, the gas pressure is lowered at a greater than linear rate. This can cause a field to become effectively depleted long before the available petroleum is exhausted. For this reason it is important to producers, and a legal requirement in most regions, to check periodically the proportion of oil to gas being produced by a well. This check is made by separating the gas, oil, and water produced from a given well, measuring the produced quantities of each over a set time, and computing the ratios of each to the others. During this same time interval, additional information is frequently sought on the condition of the well—temperature and pressure at the bottom of the hole, temperature and pressure at the top of the hole, and specific gravity of the crude oil. These periodic measurements taken together are called well-test.

The fiscal arrangements in an oil or gas field are complex. The ownership of the mineral rights to an area or lease containing one or more wells resides in one person or group of people. In a given field or portion of a field operated by one oil company, many leases may exist, belonging to many different owners. The gas and oil from a well are transferred to collecting pipes or lines and these to larger lines, etc. Prior to every junction at which oil or gas from wells with different owners is commingled, accurate measurement of oil, gas, and water flow must be made continually to provide a basis for royalty payment.

An oilfield may occupy hundreds of square miles. It may be located in jungles, mountains, swamps, deserts, rivers, bays, or in the shallow edge of the open ocean. The actual labor required to control such a vast complex is, in total, quite small. In the typical oil or gas field, however, people are employed to twist valves, start and stop pumps, read meters and data storage registers, and inspect operating equipment to assure safe and proper function. These people must either be stationed all over the fields or transported from well to well or lease to lease—an enormously expensive operation for offshore leases.

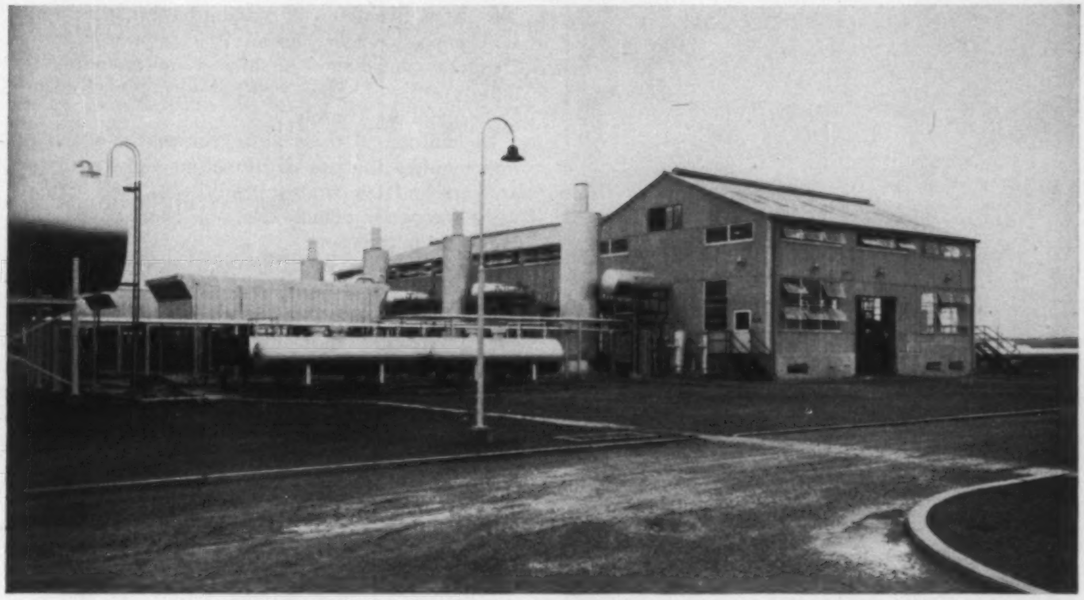


Fig. 1—Huge compressors, controlled automatically and housed in station similar to the pictured installation, create required pressure differential to move gas through pipelines.

stored in the registers are printed out either locally or remotely, together with a well identification number and the time.

▶ Gas Production

Among the simplest examples of true closed-loop automation which can be used in the field is automatic gas production. Gas flow is extremely difficult to control by simple valve setting. In addition to the fact that valves become worn, and therefore change characteristics, variation of flowing pressure causes a different flow rate with identical valve closures. Thus, in cases where flow from a gas well needs to be controlled accurately, feedback automation may be employed.

This is achieved by using an infinitely variable, electrically driven valve, together with an orifice and gas flow computer. The desired flow rate is set into the flow computer. The computer measures actual flow continuously, compares this with the flow setting to generate an error signal, amplifies the error signal which is used to adjust the valve until zero error occurs.

▶ Lease Control

In a modern lease, production operations can be controlled by local control units scattered throughout the field. These are electronic cycling units, with local, dependable power supplies, capable of indefinite unsupervised operation. They utilize static magnetic and derated transistor circuitry for extreme reliability. These units, together with feedback flow controllers, control well production, well-test, custody transfer, and tank switching. Associated with these are sensing units for dangerous conditions such as fire, broken lines, inoperative valves and pumps, tank overfilling, etc. These sensing elements, when operated, result in shutting down operations which may aggravate or be damaged by the improper condition.

The entire field is tightly linked together by a highly reliable but complex telemetering system. This system may utilize radio, light beam, microwave, or wire line communication channels for links.

The communication system permits cycle duration and order changes, flow rate setting changes, and human override of automatic control from a remote or central office. It also provides for transmission of information on troubles or other conditions to the central office, and transmission of accumulated flow and test data to the office on demand or on schedule.

Due to the vast safety and monetary responsibility of this field telemetering system, its reliability requirements are extreme. For this reason a series of telemetering terminal units have been developed specifically for this type of application. They operate over all ranges of temperature and humidity found in the far-flung oil and gas fields. They are housed and locked in rugged cabinets. The units operate effectively with the poorest telephone or radio circuits.

These terminal units are used to transmit and receive address and operation-coded messages of all necessary types. Information is generated in digital

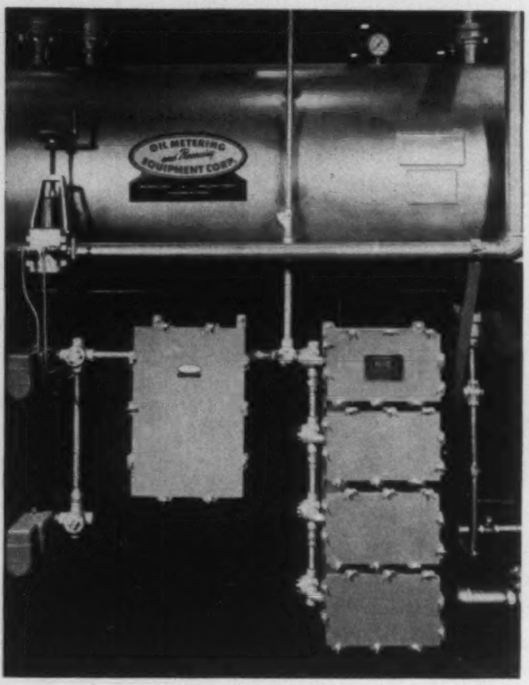


Fig. 2—Gas flow computer installed with a separator for automatic well test. Oil, gas, and water components of flow are separated and metered for a given test period. The computer utilizes pressure, temperature, and specific gravity variables to compute rate of gas flow.

form, binary bits causing gated output of tones onto the line. Information is automatically check-coded, and noise is rejected. All circuitry, including logic, tone generators, modulators, and demodulators utilize either aged transistors and diodes or static magnetic elements. No tubes or relays are used, to avoid adjustment or replacement. In the central or remote office, a control console houses necessary trouble indicators, data recorders, and data input equipment.

This type of lease operation is the best presently in use. Few systems are as complete or as thoroughly integrated as this, but several major operations are growing into such a system rapidly.

▶ Pipeline Control

A control system has been designed, and is being installed by stages in pipelines, which in magnitude, scope, and utilization of advanced techniques, is as complex as any other control system in a nonmilitary operation. This system can be assembled from five types of standard compatible units: 1. Compressor start unit. 2. Compressor station computer-controller. 3. Master telemetering terminal unit. 4. Slave telemetering terminal unit. 5. Dispatching console.

In addition to these units, conversion of a pipeline requires the use of numerous valve actuators, pressure and temperature transducers, and a single, voice frequency communications channel via wire, radio, or microwave.

The system can be built up in stages. Installing a compressor start unit permits automatic start of a compressor, automatic shutdown, automatic trouble shutdown, and trouble monitoring. Addition of a compressor station computer-controller permits the entire station to operate as a single compact unit, producing a desired discharge pressure with a continuously optimum combination of compressors on-line, compression ratio, and compressor speed. This computer-controller is a complex, multi-input, multioutput servo comparator, amplifier, stored-program computer, and data storage unit. It receives and stores a discharge pressure command by local or remote human input. It computes actual discharge pressure and compares this discharge pressure with the discharge pressure setpoint, producing a discharge pressure error. From discharge pressure error, suction pressure, suction temperature, flow rate, and certain gas constants it computes horsepower error. From its stored program and the existing developed horsepower it selects the most economical means of reducing the discharge pressure to zero by starting up or shutting down compressors, changing compression ratio, and changing speed.

With the addition of a slave telemetering terminal unit to each station and a master telemeter-

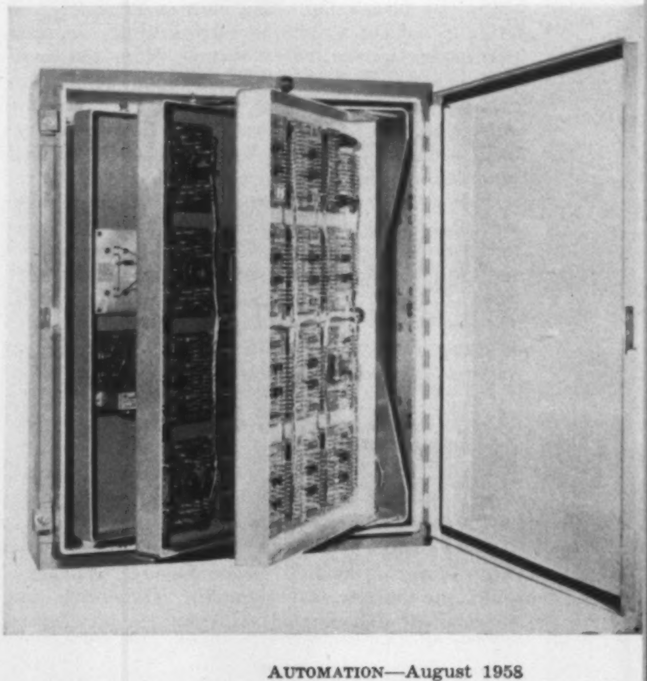


Fig. 3—Telemetering transceiver utilized by petroleum industry illustrates typical construction standards for electronic equipment. Circuits employ aged transistors and diodes or static magnetic elements.

ing terminal unit and a dispatching console to the dispatch office in the company operating center, all stations can be reset and monitored. If the pipeline operates its own gas leases, well flow controllers can be integrated into the over-all system.

▶ Improvements Possible

Two general types of automatic control systems for gas pipelines are possible: Remote reset automatic control and remote monitoring and control. In a remote monitoring and control system, detailed operating parameters of all equipment in all stations are transmitted to the pipeline dispatching office, where they are displayed and logged. On the basis of these the dispatch personnel determine specific adjustments and corrections to all controllable variables in the system and transmit control signals to the various points in the pipeline which will effect these adjustments and corrections. This, of course, is in reality a type of long range human control. The majority of systems being installed are of this type but this approach suffers from shortcomings.

First, the transmission of information and control signals is subject to some degree of error and failure caused by the physical communication system. Careful design of the communications facilities can maintain this at a relatively low level, but this aspect of unreliability is finite and cannot be ignored.

Second, the interrelation between operating variables in a given compressor station is extremely complex, and manual control of such interacting variables to a high degree of precision is virtually impossible.

Third, the response time is excessively slow for the control loops involving measurement instruments, telemetering equipment, human dispatch personnel, more telemetering, and remote actuators.

Some of the systems in use at the present time involving remote monitoring and control have been built with great care and excellent engineering for reliability of equipment. However, even these systems suffer from high installation cost, less than perfect system reliability and efficiency, and excessive demands on dispatching personnel. The use of remote reset automatic control improves the pipeline operation from all these aspects.

The final step in a major system automation program is the installation of a central direction computer. In the case of the pipeline application, this will be a dispatching computer. Research, leading to design parameters for such units is underway.

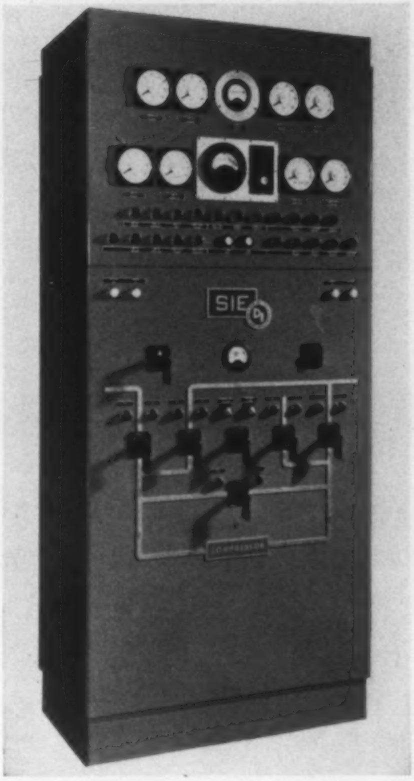


Fig. 4—Compressor start unit for gas pipeline. This control unit permits automatic start of a compressor, automatic shutdown, automatic trouble shutdown, and trouble monitoring.

When such a computer is finally installed in the dispatching office, the pipeline will almost simulate a living organism. Manual input to the computer will be weather data, prices, rates, contractual arrangements and demand predictions. The line, with this information, will buy its own gas, sell its own gas, write and mail its own bills, obtain needed gas at the right time at the lowest available rate, and notify its human supervisors when it is in trouble.

improved magnetic tape

RADICAL new "sandwich construction" magnetic tape has been announced by Minnesota Mining and Manufacturing Co.

Secret of the new tape is a thin, low-friction, plastic layer over the magnetic coating which prevents the oxide from contacting the recording head at any time, thereby eliminating wear on the oxide itself. Yet because the plastic layer—purple in color—is only 50 microinches thick, critical head-to-tape contact is sufficiently intimate for all instrumentation recording applications except those where extremely high frequency response is required.

By eliminating oxide rub-off, the new sandwich tape provides greater reliability and freedom from signal error—especially critical in digital computer applications.

The new sandwich tape is expected to find wide use in several fields, including such fields as digital computer applications and numerical control by magnetic tape of automated machine tools.

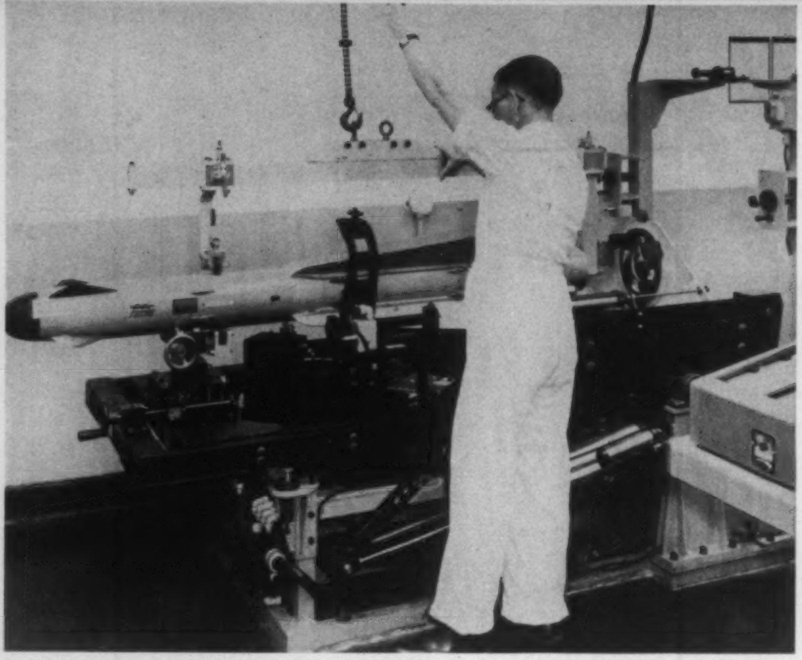


Fig. 1 — Special machine uses strain gage sensing elements to weigh Falcon missiles and determine location of center of gravity of the completed missile. Falcon is manually loaded into machine. Weight, longitudinal location of the center of gravity, and location of the center of gravity in the lateral cross section of the missile are recorded on a chart.

AUTOMATIC BALANCE CHECKING

SPEEDS MISSILE PRODUCTION

Many of the manufacturing problems in production of missiles have been solved by applications of automatic devices. A case in point is the checking of center of gravity and thrust alignment for Falcon missiles. Electric strain gage elements are the primary sensing devices, and results are recorded by an automatic printer and an X-Y plotter.

TO PERFORM its function, a Falcon air-to-air missile must have its center of gravity properly located with respect to its surfaces and properly aligned with the line of thrust of its propulsion unit. Each missile must therefore be carefully checked to locate its center of gravity and insure proper thrust alignment. This is an exacting job that can keep three men busy for 1½ hours on a single missile.

At Hughes Aircraft Co. where such missiles are made, one operator with an automatic piece of equipment accurately performs this checking job in about 5 minutes, and makes a permanent record of the test results. This machine was designed and built by the Electronics and Instrumentation Div., Baldwin-Lima-Hamilton Corp. and cost $74,000. In the first six months after it was installed, the machine saved more than $10,000 in testing costs; at which rate this saving alone will amortize the investment in less than four years.

Each of these missiles is about six feet long and weighs approximately 125 pounds. They are loaded horizontally into the machine, *Fig.* 1, which can do the following things: Measure the weight of the missile. Find the center of gravity. Indicate the thrust alignment. Repeat measurements on the same missile within 0.0005 inch.

The center of gravity is defined by locating three mutually perpendicular planes in which this center lies. In this machine the locations of these planes are given as distances from predetermined reference points. The figure for "longitudinal C. G." defines the point of equilibrium along the length of the missile. It is expressed in inches and determined to an accuracy of 0.015 inch. The other two planes define the location of the center of gravity in the lateral cross section of the missile. These planes are at right angles to each other and their distances from a reference point are described as "lateral C. G. *X*" and "lateral C. G. *Y*". The resultant of these two measurements is termed "lateral C. G." and is determined to an accuracy of 0.002 inch.

After the center of gravity of the missile is found, thrust alignment deviation is determined. It shows in inches the distance between the thrust line of the missile and the center of gravity. This indication is made to an accuracy of 0.002 inch.

▶ Machine Operation

The Falcon missile leaves the production line and is brought to the checking machine by an overhead monorail conveyor. Using an air hoist, the operator loads the missile into the checking machine in a horizontal position. Proper positioning of the missile in the machine is provided by a pin which fits into a hole in the missile during positioning and then is retracted. The missile rests on rollers while being lined up.

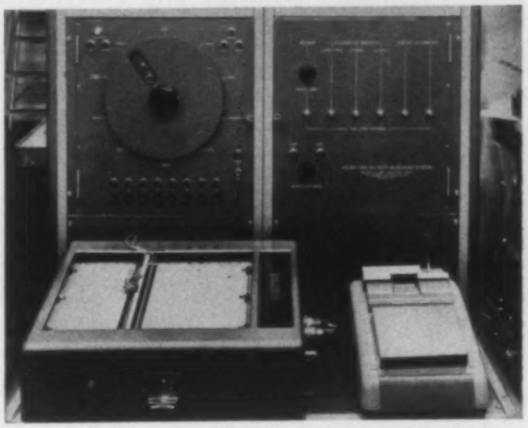
For the next step, the operator turns the manual programming switch to the stop marked *Weigh*. This switch has a large metal disc covering the operating buttons, and a radial slot in the disc permits only those buttons to be pressed which should be actuated at that point of the cycle. With the missile in proper position, the operator presses a button on the control console, *Fig.* 2, and the missile is lowered until it rests on a cradle mounted on a load cell which weighs the Falcon. A Clary printer stamps a figure for this weight on the lower left corner of the chart for that missile.

The program switch is next positioned to *Longitudinal C. G.* The measurement for longitudinal C. G. is made by the same load cell and also printed on the record chart by the Clary printer. The operator then removes the chart from the printer and mounts it in a Moseley X-Y plotter.

Lateral C. G. is determined using again the same load cell while the missile is still in the horizontal position. A lateral C. G. *X* measurement is made first. Then the missile is rotated 90 degrees around its long axis and a lateral C. G. *Y* measurement is made. These two readings are automatically combined to give the lateral C. G. determination which the plotter records on the chart as a dot within a small circle.

Following pushbutton commands, the machine automatically raises the missile to a vertical position and lowers it onto a mandrel in a thrust alignment fixture, *Fig.* 3. Thrust alignment is determined using two special Baldwin-Lima-Hamilton bonded wire strain gage beams attached to the mandrel. The beams provide separate pickups for deviations from the thrust axis in two vertical planes through the longitudinal axis of the mandrel. Deviations in these two planes are combined to give a single thrust alignment reading in the longitudinal C. G. plane. The plotter records this information on the chart as a cross.

When the measurements are completed, the missile is returned to the horizontal position. The operator lifts it out of the machine with the air hoist, and the Falcon is sent on its way.



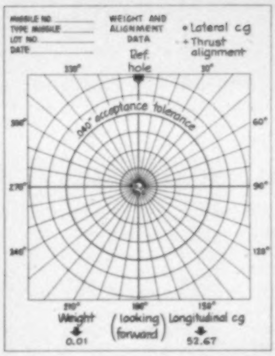


Fig. 2—Control console features a programming switch which helps maintain sequence of actions by covering pushbuttons not related to the part of the cycle being performed. The automatic printer and the X-Y plotter record test results for each missile on a chart such as shown in the accompanying closeup.

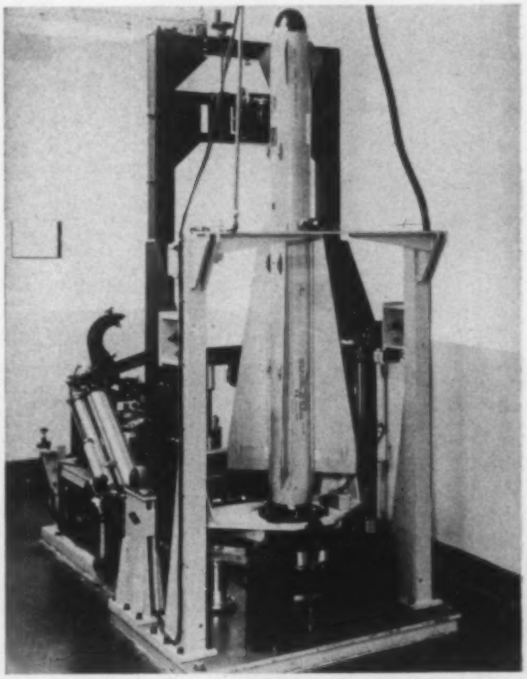


Fig. 3—To determine balance of the missile about the thrust axis, it is turned to the vertical position shown. A mandrel fits into the thrust cone of the missile and the location of the center of gravity of the missile with respect to the centerline of the mandrel is automatically recorded on the chart by the X-Y plotter.

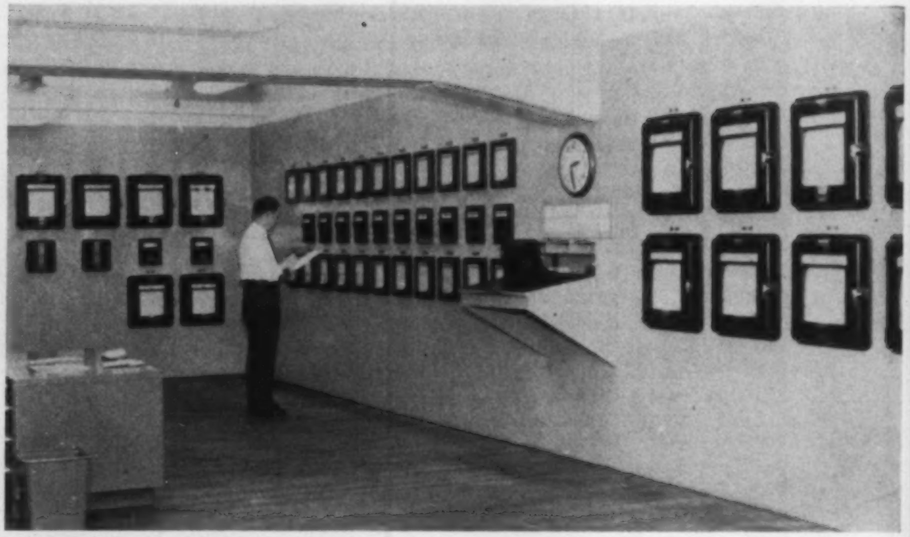
automation

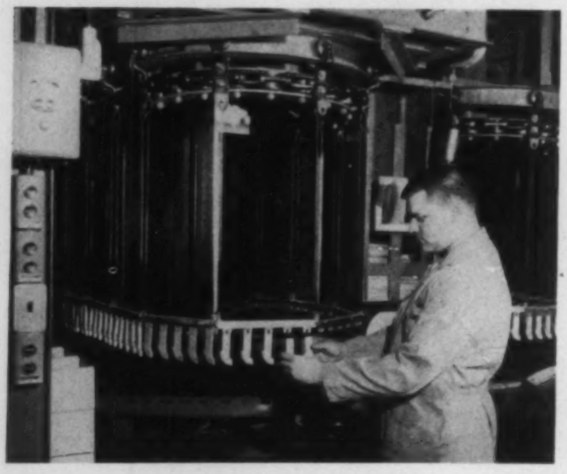
Special Drilling Unit

NYLON-PLUGGED self-locking machine screws with an O.D. as small as 0.050 inches are manufactured by the Nylok Corp. To produce these small items in quantity needed, the company has designed special automatic equipment capable of turning out 60 finished screws a minute. The basic screw is hopper fed to the special machine, which in successive steps, rough drills a hole in the threaded portion of the screw, finish drills the hole, inserts the nylon pellet, tamps it, and then inspects the finished screw. The company has also designed a machine to automatically insert nylon pellets into nuts.

Heat Treat Control

EXTENSIVE heat treating requirements for typewriter parts at a National Cash Register Co. plant have led to the use of a centralized control room for the heat treat department. From the control room, one man oversees the entire operation—receiving records of incoming jobs, determining what treatments are called for by specifications, scheduling the heat treats, setting desired oven temperatures on control instruments, and recording of pertinent data. Production records are created by posting data directly on the various Leeds & Northrup Co. strip charts mounted on the wall of the control room. Approximately 900 million parts a year are handled through this heat treat department.

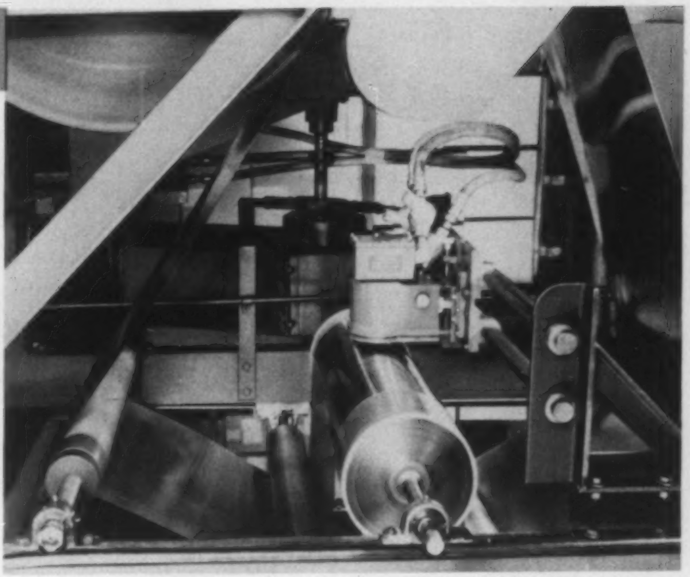




Painting Fixture

FACED with the problem of dip painting a variety of sizes and shapes of Carboloy mining tools in mixed lots and small-quantity orders, Metallurgical Products Dept. of General Electric Co. has turned to permanent magnet fixtures. Mechanical fixtures to hold the tools on the conveyor during the finishing operation proved to be unduly complex and troublesome. The one-ounce horseshoe magnets are attached to suspended channel sections, about 12 inches long. To prevent mutual attraction of adjacent magnets, the magnets are hung with like poles next to each other. Parts are loaded and unloaded from the magnets by hand.

in action

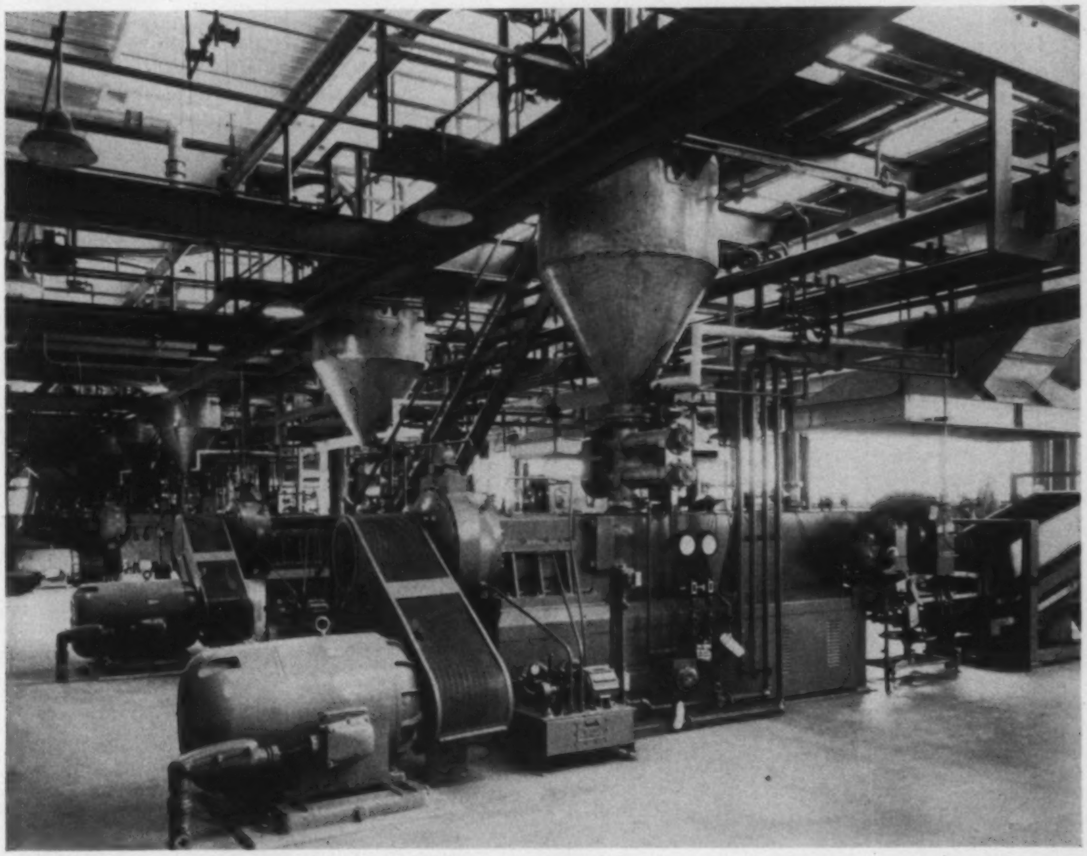


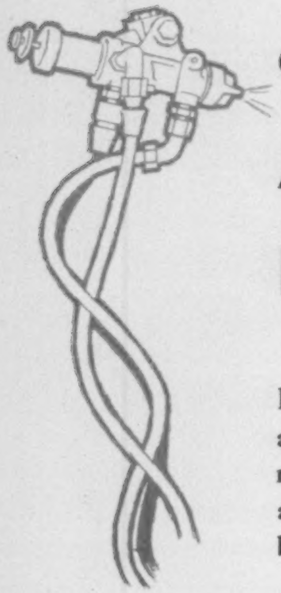
Thickness Gage

BETA GAGES are employed by the Armstrong Cork Co. in several of its plants. Illustrated is one application in which a gage using radioactive strontium 90 is used to control the amount of adhesive applied to aluminum foil. Subsequently, small discs will be stamped from the foil and attached to the cork lining typically found in crown closures for bottling certain beverages such as beer. Exact amount of adhesives is critical since too little can result in a loose foil disc, and too much will spread beyond the disc and make a messy closure. Radiation gage contains both the source and detection in one head. Radiation is reflected off the foil, and variation in the thickness of adhesive is indicated by a change in the reflected count of radiation.

Plastics Production

TYPICAL polyethylene manufacturing facilities contain in the latter stages of the production line a water cooling bath, approximately 50 feet long, that receives spaghetti-like strands from an extruder. Plant established by Polymer Chemicals Div., W. R. Grace & Co., has improved on this technique by integrating several additional pieces of equipment into the production line. As strands of polyethylene resin start from the extruder, they are chopped by a rotating cutter into tablet size pellets. The pellets are cooled in a short water bath and then air dried on a conveyor tray before proceeding to a bagging operation by a pneumatic conveying system. Plastic fabricators purchase the bagged pellets of high density polyethylene for manufacture of toys, housewares, battery cases, automotive parts, and similar items where toughness and rigidity are important.





CONSIDERATIONS IN SELECTING

AUTOMATIC PAINTING EQUIPMENT

Effective painting of a manufactured product can add sales appeal that makes it superior to competitive products. Automatic painting can reduce finishing costs to help hold the line against rising prices. This article outlines factors which should be considered before procuring automatic painting equipment.

By **ERIC H. COCKS,** Plant Manager, Eclipse Air Brush Co., Newark, N. J.

RISING COSTS force the efficient plant manager to investigate all possible means of lowering the final cost of product in order to stay competitive with other manufacturers of similar products. Automation—through automatic machinery, upgraded handling means, and integrated control systems—is one method of holding the price line in the face of increased material, labor, and overhead costs. For most production processes the challenge of automation has been recognized, and there is ample information available for a wise selection of automatic machinery, versatile tooling, and time-saving fixtures. However, such is not the case when one is investigating methods and equipment for upgrading finishing operations, such as spray painting.

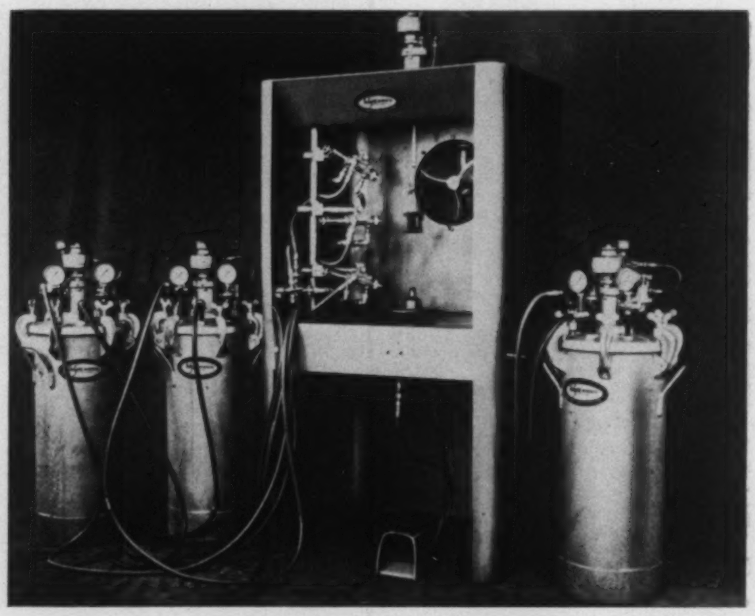


Fig. 1—Simplest type of automatic paint spray equipment for relatively small parts includes a spray booth, multiple spray guns, and means for rotating the part. Parts may be suspended from upper rotary drive unit or may be placed on lower turntable. Conveyors can be used to bring parts to spray unit where they are manually loaded onto rotary units. After automatic spraying with fast-drying paint, parts can be manually unloaded and carried to next operation by conveyor.

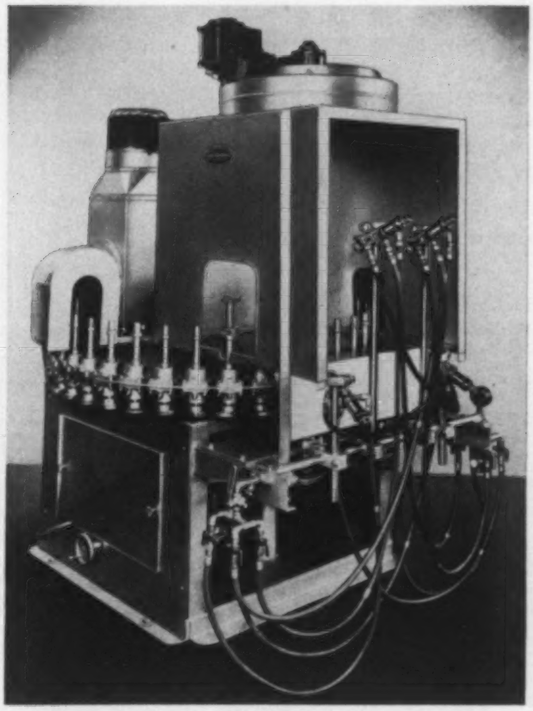


Fig. 2—Rotary indexing turntable type spraying machine provides an automatic painting operation. Parts are loaded onto carriers outside of spray booth, indexed into spray position, rotated while being sprayed, and indexed through a drying oven. This type unit is suitable for small parts that are symmetrical about one axis such as military shells and golf balls.

Although spray painting can also be automated to a high degree, there is little general information available to guide management in selecting this equipment.

Automatic spray painting is not new. During the early years of the lacquer industry, several installations were made to coat various products at a high rate of speed. World War II added impetus to the special machinery field, and hundreds of spray painting machines were built to finish defense products at high speeds. The more recent emphasis on automation throughout industry has also spread to the spray paint field with more manufacturers becoming aware of the necessity for automatic spray finishing equipment. Many manufacturers have made the mistake of considering the painting of a product as something to do after the production line headaches are over—a few cans of paint hastily applied finishes the job. This could not be farther from the truth. A well applied coating protects the product, hides the blemishes, and gives the product sales appeal which may be all that makes it superior to a competitor's product.

▶ Advantages of Automatic Spraying

One advantage of automatic painting is that it enables a reduction in man-hours charged against the finishing operation. On simple painting machines, skilled painters can often be replaced with semiskilled labor. On larger, more complex equipment it is usually necessary to retain an attendant who has a mechanical aptitude and a good basic knowledge of spray painting. Another major advantage is that with automatic painting, the finishing department need not be a bottleneck operation. It can be scheduled with the same degree of reliability as experienced with other pieces of automatic equipment.

Unlike the human operator handling spray equipment, automatic spray machines do not tire or decrease in efficiency at various periods during a shift. Automatic equipment repeatedly produces a superior finish than can be obtained manually, and there usually will be savings in material.

Preparation of an article for automatic painting will not differ greatly from than used when painting manually. In both cases, the article must have a surface which will accept the type of coating being used. The type of pretreatment should always consider the coating system as a whole, and the supplier of paint should be consulted for his recommendations in the early stages of the planning.

The equipment needed for automatic painting will vary from a timer-operated spray gun, *Fig.* 1, to a complex mechanism that includes all the modern devices available to industry today. Basically, automatic spray equipment requires a means for carrying the part to be painted, for correctly locating it during the coating, and for supporting it until the coating has dried sufficiently for the part to be

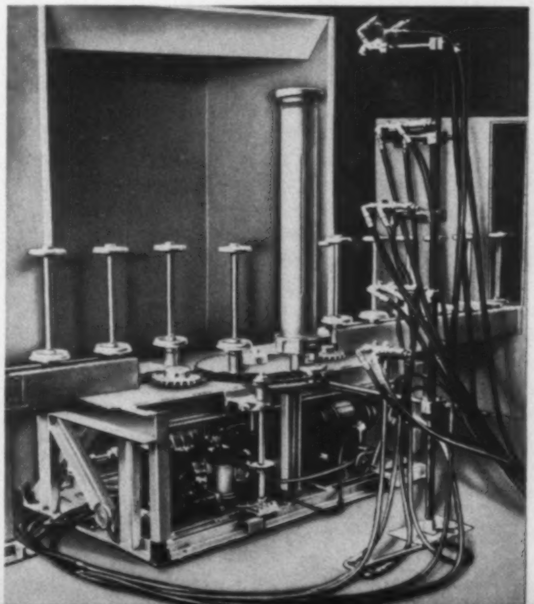
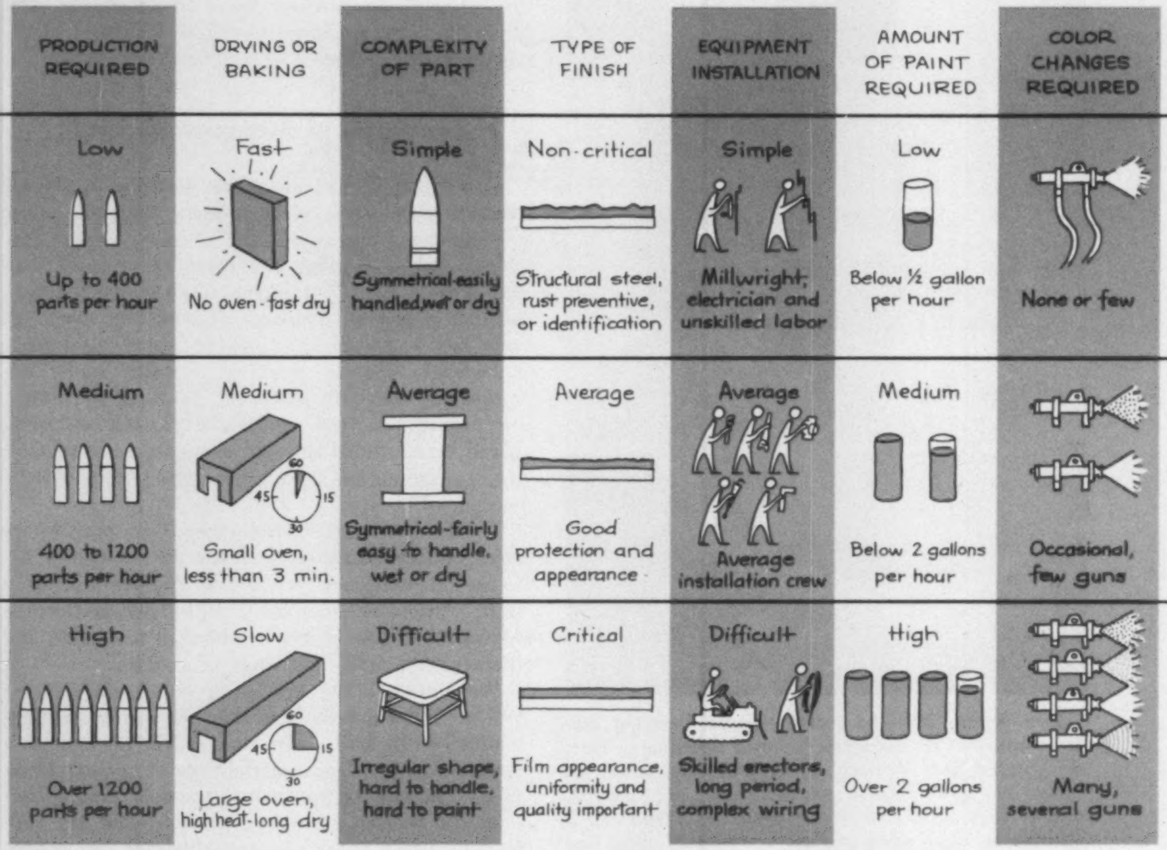


Fig. 3—Spindle type chain conveyor spraying machine will handle large parts which are symmetrical about one axis. Parts are loaded onto spindles, moved into spray position where a small drive chain causes the spindle to rotate while paint is applied, and then progress through a drying oven.

PRODUCTION FACTORS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	PRODUCTION REQUIRED	DRYING OR BAKING	COMPLEXITY OF PART	TYPE OF FINISH	EQUIPMENT INSTALLATION	AMOUNT OF PAINT REQUIRED	COLOR CHANGES REQUIRED
1 Point severity rating	Low Up to 400 parts per hour	Fast No oven - fast dry	Simple Symmetrical-easily handled,wet or dry	Non-critical Structural steel, rust preventive, or identification	Simple Millwright, electrician and unskilled labor	Low Below ½ gallon per hour	None or few
2 Point severity rating	Medium 400 to 1200 parts per hour	Medium Small oven, less than 3 min.	Average Symmetrical-fairly easy to handle, wet or dry	Average Good protection and appearance	Average Average installation crew	Medium Below 2 gallons per hour	Occasional, few guns
3 Point severity rating	High Over 1200 parts per hour	Slow Large oven, high heat-long dry	Difficult Irregular shape, hard to handle, hard to paint	Critical Film appearance, uniformity and quality important	Difficult Skilled erectors, long period, complex wiring	High Over 2 gallons per hour	Many, several guns

Fig. 4—When evaluating the cost of procuring automatic spray equipment, the production factors outlined should be considered. Each factor is rated with severity values from 1 to 3. In analyzing an existing process for possible conversion to automatic equipment, each production category should be assigned a point value for severity, and the points totaled. The most feasible range for installing automatic equipment is a point total between 7 and 14. When the total is greater than 14 points, process should be reviewed in order to reduce the severity of factors in some categories before automatic equipment is considered.

removed from the carrier fixture. The carrier must then have means for returning the part to a loading station for the next part.

▶ Effect of Product Design

In considering automatic equipment for spray painting, one factor that must be given careful evaluation is the form of product to be coated. Products can usually be divided into three categories: 1. Two-dimensional surfaces. 2. Regular shaped objects. 3. Irregular shaped objects.

Two-dimensional surfaces: A typical example of this type of product would be fibre or wallboard. To paint these with automatic equipment, the part would be carried on an open-type conveyor. An automatic gun would be reciprocated perpendicular to the conveyor travel so that the gun sprays a steady, blending, criss-cross pattern over the work. Paper, leather hides, backing for mirrors, and similar objects are painted in this manner.

Regular shaped objects: Products of this type are generally symmetrical about one axis. They are usually carried on an indexing turntable, *Fig.* 2, or on a spindle chain conveyor, *Fig.* 3, and are rotated at a high rate of speed while being sprayed. In most cases, it is preferable to have the carrier or indexing mechanism stationary while the rotated part is being sprayed as this will minimize offspray and permit the maximum in repetition of results. Military shells, lamp shades, and golf balls are often painted by this method.

Irregular shaped objects: Products in this category are generally asymmetrical, and their surfaces would be varying distances from the spray gun if rotated. Depending upon the size and shape of these products, they usually require specially designed installations for automatic painting. Small objects can be carried on spindle chain conveyors or indexing turntables while large objects are hung from overhead conveyors. Products in this category would be chairs, large boxes, and asymmetrical machine parts.

Some products require painting on their interior surfaces. Special considerations are necessary in designing spray equipment for these articles. Regular shaped objects which might be painted on the inside would be a can, drum, barrel, military shell, tube or pipe. An irregular shaped object requiring inside coating would be a GI gasoline or water can.

▶ Design Factors

The design of any machine represents a compromise of many excellent features with some which are less desirable. This is due to the fact that any ultimate design must be tempered with practical considerations of production, initial cost, ease of maintenance, ease of loading and unloading, installation requirements, shipping facilities, and other miscellaneous factors.

Cost is greatly influenced by production requirements and drying time, *Fig.* 4. For example, if a particular part was to be painted at a rate of 600 pieces per hour and required a drying time of three minutes per part, it could readily be handled on a simple four-foot indexing table. However, if the production rate or the drying time were increased, then the four-foot indexing turntable would not be sufficient and a chain type conveyor would be required. The larger unit would require additional tracks, supports, horsepower, shafts, sprockets, and other parts, and the cost would be considerably higher than that for the indexing table.

From a design point of view, there is no type of chain conveyor which will hold a product as steady as a turntable unit. The turntable also lends itself to both inside and outside spraying whereas a chain conveyor is not as reliable for interior painting.

The turntable unit is most generally used with a lacquer system where a minimum of baking or drying equipment is necessary. Of course, with some modern synthetics—particularly the catalyst types—extremely fast drying can be obtained. Type of paint, speed of drying, and baking or heating requirements should be firmly established before automatic spray equipment is considered, for they have a direct effect upon the cost of the final equipment.

Where automatic equipment is to be fitted into a production line, provision should be made so that the equipment is flexible enough to cope with future situations that might arise. These could include the desirability of passing the article through the machine without painting, the ease with which maintenance can be carried out, and the possibility of changing a product design which would require a slightly different spraying operation than originally designed for the machine.

The machine should be designed as simply as possible in keeping with the work it is to do. It must be sturdy with special attention given to the spindle or holder that will carry the work. Mechanical movements should be designed so that they will be positively operated. In many cases maintenance will be neglected, and paint will be allowed to accumulate on moving parts of the machine. Part tolerances should be as generous as possible so that these accumulations will not build up and stop the machine. All electrical equipment should be enclosed in vapor-proof boxes, and explosion-proof motors are usually required on painting equipment.

In many cases the use of hydraulically-operated components will be advantageous while on simpler machines pneumatic operation is sufficient. On high production machines it is essential that safety devices be included so that the machine can stop itself or the work in cases of emergency. Controls should be kept as simple as possible and should be interlocked so that malfunctioning cannot occur through negligence of the operator. When production speeds are changed frequently, provisions should be included to make changes as easily and fast as possible.

▶ Auxiliary Equipment

Another item which reflects upon the final cost of the machine is the amount of auxiliary equipment furnished. In some cases where multiple colors or frequent refilling is required, it is desirable to have paint supply tanks manifolded together. Another auxiliary time-saver is the use of a separate tank manifolded into the system for holding solvent for cleaning the system. Every installation should have adequate capacity air filters. With multiple gun installations, the use of fluid regulators and individual air regulators for each gun is desirable. All of these accessories increase the cost of the unit, but they aid maintenance, cleaning, and result in better control of equipment and finish.

▶ Final Considerations

There are many variables that affect the painting operation over which the manufacturer has little control. The viscosity of the paint may change, air pressure to the spray nozzles may drop, spray guns and nozzles may require cleaning. In other cases quality control or final inspection will require more or less paint. There may be color changes required for certain products. In most cases it is advantageous to use an experienced painter for machine operation. However, with correct guidance, relatively unskilled personnel can operate an automatic painting unit. A positive must by supervision is that sufficient time be provided for the necessary cleaning and maintenance.

When first installed, anything other than the simpler type of automatic unit will probably require more attention than may have been anticipated. However, this extra effort diminishes rapidly as experience is gained with the unit. After the machine is installed and placed in operation, the know-how of the machine supplier and the paint vendor becomes invaluable in keeping it in operation, for both have gained wide experience from many other painting installations. When a problem arises, they usually can recommend a quick and efficient solution requiring the minimum of downtime or cost.

BROKE HANDLING SYSTEM SPEEDS PULP RECOVERY

BROKE—the waste pulp, damaged paper, and trimmings from papermaking operations—is automatically reclaimed and reprocessed in a new paper mill installation at P. H. Glatfelter Co. Installed as a part of a recent expansion program, the system includes a Brokemaster repulping unit designed by E. D. Jones & Sons Co.

Two separate conveyors are used to collect and feed broke and paper trimmings to the repulping tank. Broke from the last section of the paper machine falls onto a conveyor, *Fig.* 1, built by Gifford-Wood Co. This conveyor is made up of three 4-foot wide continuous belt sections. Paper trimmings fall through chutes in the finishing room floor onto a steel trough suspended below. They are conveyed to the repulping tank by a drag chain.

▶ Operation and Control

The system, *Fig.* 2, includes a photocell and light source to sense the falling of broke from the paper machine onto the conveyor below. If the liquid level in the repulping tank is neither too high nor too low, interruption of the light beam by falling material starts this conveyor and opens a shower valve in the repulping tank. As broke is fed into the repulping tank, water is added in accordance with a control panel setting to provide a 4 per cent solids consistency of the new material.

Automatic control of the system is effected through a liquid level sensing device on the repulping tank. This unit reacts to five level conditions in the tank.

When the liquid in the tank drops to level *A*, *Fig.* 2, both pumps are shut off, the broke conveyor is inactivated, the shower valve opens, and an alarm sounds. The pumps are prevented from starting immediately on level increase by a time delay device.

When the level in the tank is decreasing and drops to control level *B*, the 3-way valve is operated to its *Recirculate* position and the 100 gpm pump starts. Thus, the pulp is recirculated from the bottom to the top of the tank through a consistency regulator. The latter unit maintains pulp consistency at a 4 per cent solids level by automatically adding water as needed.

An increase in the level in the tank to *C* places the 3-way valve in its *System* position and starts the 605 gpm pump. Both pumps are then used to draw off pulp to the paper machine where it is reprocessed into paper.

If the tank level should increase to *D*, an automatic throttling valve in the 605 gpm pump outlet line is opened to increase the flow of pulp from the tank.

At the highest control level, *E*, the shower valve is closed and the broke conveyor is inactivated.

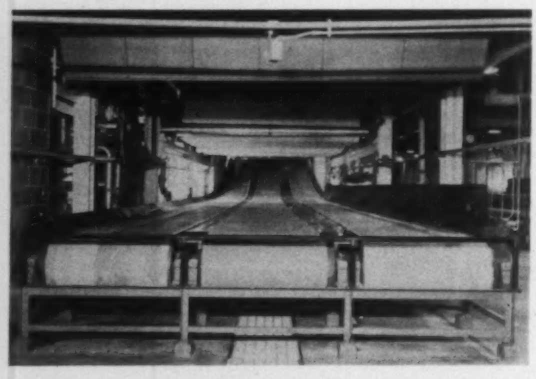
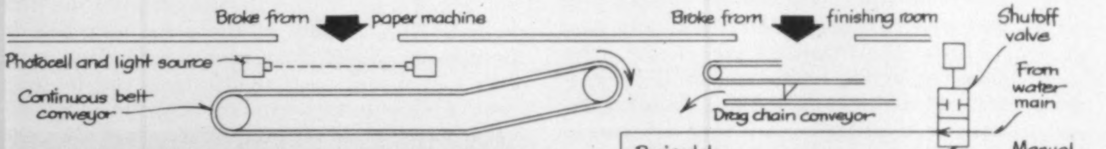


Fig. 1—Conveyor receives broke from paper machine on floor above. Photoelectric cell, visible at top center, senses falling material and starts conveyor to deliver broke to repulping tank.


Broke from paper machine
Photocell and light source
Continuous belt conveyor
Broke from finishing room
Drag chain conveyor
Shutoff valve
From water main

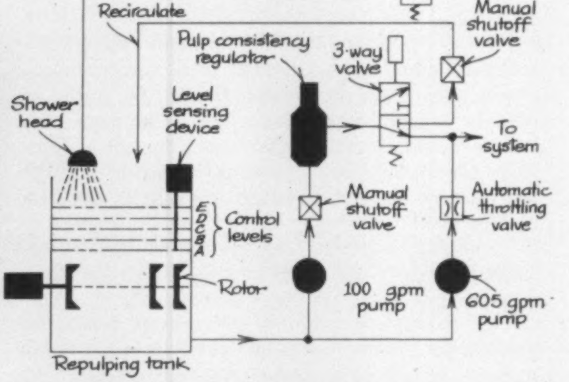

Recirculate
Pulp consistency regulator
3-way valve
Manual shutoff valve
Shower head
Level sensing device
To system
E
D
C
B
A
Control levels
Manual shutoff valve
Automatic throttling valve
Rotor
100 gpm pump
605 gpm pump
Repulping tank

Fig. 2—Diagram of repulping system which handles broke from paper machine and finishing room. Tank level and pulp consistency controls may be operated manually or automatically from a panel.

HYDRAULIC CONTROL OF
AUTOMATIC MACHINERY
SYNTHESIS OF SYSTEMS . . . 7

HYDRAULIC AND ELECTROHYDRAULIC SERVO SYSTEMS

Servo systems are establishing a permanent place in industry because of their unique advantages in the control of automatic machinery. In this seventh and final part of a series covering the synthesis of hydraulic control systems some of the types, characteristics, and uses of hydraulic and electrohydraulic servo systems will be examined.

By R. HADEKEL, Engineering Mgr., Sunbury Div., Sperry Gyroscope Co., Ltd., Brentford, England

HYDRAULIC servo systems may be classified according to the methods by which their servo valves are operated. These methods may be designated *direct* and *indirect.* By direct operation is meant mechanical actuation without the interposition of electrical or pneumatic transducers. Direct operation is usually confined to use in the more elementary types of servo systems such as force amplifier of follow-up systems. Examples are vehicle steering systems, *Fig.* 36 (See Part 4—AUTOMATION, Feb. 1958), and some copying lathe arrangements.

Direct Operation

In direct operation the desired action is obtained by deriving an error signal in the form of mechanical displacement and applying this signal to the servo valve. The error signal is derived by subtracting from the input displacement a second displacement representative of output. The latter displacement is termed feedback, and in the simpler servo systems may be achieved virtually, *Fig.* 36 and 64.

In these virtual feedback arrangements the valve body is mounted so as to travel with the output member. An input signal that displaces the valve spool causes motion of the output member and valve body by admitting pressure to one end of the output member and connecting the other end to tank. Motion continues until the valve body, moved by the output member, is repositioned with respect to the displaced valve spool so that a balanced, or zero-flow, condition is established. Should the output member and the valve body tend to overshoot, a restoring force will be created by reversal of flow through the servo valve. There is thus a positive position of the output member corresponding to each position of the valve spool, assuming constant load and hydraulic pressure.

Virtual feedback systems have the advantage of mechanical simplicity but involve supplying oil to the servo valve and output member through flexible hoses, rotary joints, or arrangements that can provide similar action.

Subtraction of feedback displacement from input displacement to produce an error displacement can be accomplished mechanically through use of differential gear and lever arrangements. The device of *Fig.* 65 illustrates use of a lever differential for this purpose. Here, the servo valve is mounted on the output member as in *Fig.* 64, but the valve and cylinder bodies are held stationary. In this case the components are fastened together to keep down the volume of oil between them and thus improve system stability by reducing oil elasticity effects.

Systems that use differential gear or lever arrangements do not require flexible supply means and provide other advantages over virtual feedback circuits which will be explained.

▶ Servo Valve Gain

In the discussion to follow it will be assumed that: Steady-state conditions prevail; oil compressibility, leakage, and friction effects are negligible; and valve port areas are proportional to the displacement of the spool of the servo valve from neutral up to the point of maximum port area.

Using the notation listed in the NOMENCLATURE: The flow Q through the valve in a servo system such as diagrammed in *Fig.* 64 and 65 is

$$Q = Ca\left(\frac{x}{X}\right)\sqrt{\frac{P_s - P_d}{2}} \qquad \text{(1)}$$

as derived from basic fluid flow principles. When x exceeds X a value of 1 is assigned to the ratio x/X. This flow is load-sensitive in that, for a given valve spool displacement x the flow is greatest for a no-load condition and decreases when a load is applied. The effect is illustrated in *Fig.* 66.

Servo valve gain G is expressed in terms of the flow through the valve per unit valve spool displacement from neutral, or Q/x. It can be represented graphically as the slope of a line on a graph such as that shown in *Fig.* 66 for a given load condition, or it may be derived mathematically from Equation 1 as

$$G = \frac{Q}{x} = \frac{Ca}{X}\sqrt{\frac{P_s - P_d}{2}} \qquad \text{(2)}$$

In the case of operation of the servo at no load, certain simplifications can be applied to Equation 2. The value of differential cylinder pressure P_d be-

NOMENCLATURE

a	maximum area of one valve port (obtainable when $x \geq X$)	in.^{2}
A	effective area of piston	in.^{2}
C	valve flow constant which contains factors for discharge effects at valve ports, oil density, acceleration of gravity, and conversion of flow theory equations from foot to inch units (with the units chosen for this discussion the value of C may be taken as 100 for a wide variety of valve port configurations and hydraulic fluids)	const.
G	servo valve gain, or flow per unit valve displacement from neutral	in.^{3}/sec/inch
K	servo loop gain, or output velocity per unit servo error, error being referred to output	sec^{-1}
P_1	pressure at inlet side of cylinder	psi
P_2	pressure at outlet side of cylinder	psi
P_d	differential cylinder pressure ($P_d = P_1 - P_2$)	psi
P_s	supply pressure	psi
Q	flow through valve	in.^{3}/sec
R	ratio of valve spool travel to cylinder travel as determined by any linkage between them	const.
w	width of valve ports in a direction perpendicular to valve spool axis	in.
x	valve spool displacement from neutral	in.
X	valve spool displacement from neutral at which valve ports first become fully open	in.

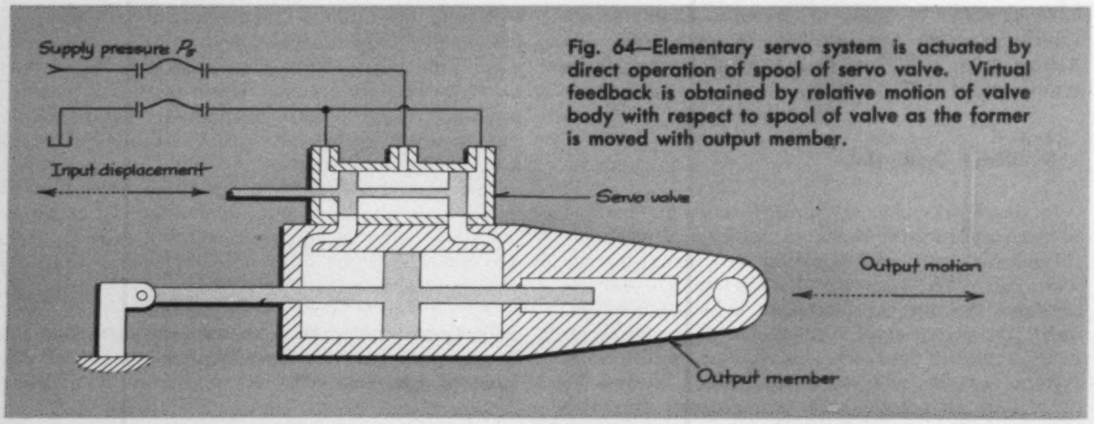


Fig. 64—Elementary servo system is actuated by direct operation of spool of servo valve. Virtual feedback is obtained by relative motion of valve body with respect to spool of valve as the former is moved with output member.

comes zero under these conditions and

$$G = \frac{Ca}{X}\sqrt{\frac{P_s}{2}} \quad \ldots\ldots (3)$$

If a servo valve is used that has ports of constant width w in a direction perpendicular to the valve spool axis, a further simplification is possible. The maximum area a of the ports then becomes equal to wX, and Equation 3 can be reduced to

$$G = Cw\sqrt{\frac{P_s}{2}} \quad \ldots\ldots (4)$$

▶ Servo Loop Gain

Servo loop gain K is an expression of the output velocity obtainable per unit servo error, error being referred to the output. It may be computed from

$$K = GR/A \quad \ldots\ldots (5)$$

When the valve body is mounted on and carried by the output member as in *Fig.* 64, the value of R is 1. Differential gear and lever arrangements such as the one diagrammed in *Fig.* 65, however, offer the advantage that values of R other than 1 can easily be provided. This enables the servo designer to obtain a desired value of servo loop gain K virtually independently of the valve gain G of a servo valve that might be on hand or readily available. Further, by specifying a valve that has a high value of gain G, and reducing the servo gain K through a suitable linkage or gearing arrangement, the valve loads felt at the input can be reduced.

Valve loads arise from so-called "Bernoulli" forces due to hydrodynamic effects in the valve, from friction forces due to hydraulic lock, and from seal friction. Friction forces in particular may cause the servo to have an unpleasant feel when it is manually operated. On the negative side, differential gear and lever mechanisms require careful design to eliminate backlash.

The value of servo gain K is a rough measure of the dynamic performance that can be expected of a servo system; in general, the servo will not be capable of handling signals of frequencies higher than $K/2\pi$ cps.

Steady-state and dynamic performance requirements usually determine the desirable minimum value of servo gain. There is no object in providing any more servo loop gain K than these requirements dictate, since the higher the gain the greater the possibility of system instability.

▶ Stability Considerations

In simple hydraulic servos of the type under discussion the occurrence of instability is the result of load inertia and elasticity in the system. Load inertia is usually a predetermined factor in the design, but system elasticity effects can be minimized.

System elasticity may be due to mechanical elasticity between the cylinder and the load or at the cylinder attachment point. It also results from elasticity of the oil in the cylinder.

Elasticity between the cylinder and the load is outside the servo loop. It can be shown that it will not usually of itself produce instability, although it will definitely decrease the degree of damping of the servo. Elasticity of the oil is not very large in most cases, yet may not be negligible. Elasticity at the cylinder attachment point is particularly dangerous, and its effect is magnified if the structure to which the cylinder is attached has natural vibration modes of frequencies low enough to fall within the response range of the servo.

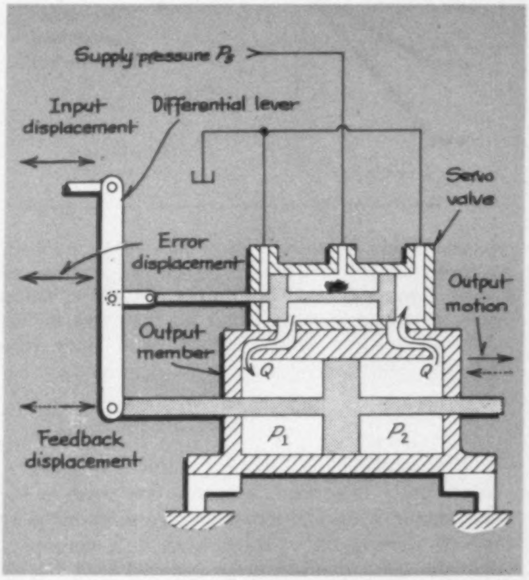


Fig. 65—Differential lever arrangement permits continuous subtraction of feedback displacement from input displacement to provide varying error displacement. Output member stops when error displacement becomes zero.

The deleterious effects of attachment point elasticity can be counteracted by a suitable arrangement of the local linkage. The general principle is to design the system in such a manner that if the attachment point yields under a force applied to the cylinder the servo will also yield, preferably by twice the amount. Thus, the arrangement of *Fig.* 64 is not ideal in that yield of the cylinder attachment point will open the servo valve by the same amount and tend to restore the initial position of the output member or its final position if an error signal is present. With the arrangement of *Fig.* 65, however, deflection of the attachment point will displace the valve body with respect to the spool of the valve in a direction tending to make the servo yield further, and better stability will result. A similar effect is obtained with the linkage of *Fig.* 67,

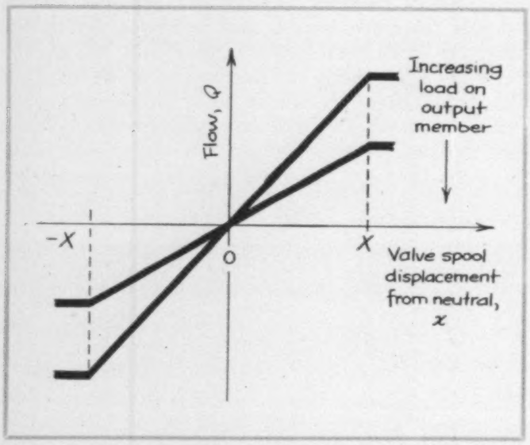


Fig. 66—Graph illustrates flow versus valve spool displacement characteristics for a typical servo valve. Effect of increasing load on output member is to reduce slopes of curves in their initial portions and to limit values of saturation flow (horizontal lines) when valve ports are fully open.

which is applicable in moving cylinder systems.

Most other measures commonly employed to stabilize simple hydraulic servos involve the same principle of altering the characteristics in a manner to cause the servo to yield to an external load.

One method is to employ a valve having a suitable amount of underlap, but this may lead to excessive power waste. A similar but less wasteful method is to introduce a shunt leakage path across the cylinder, *Fig.* 68. In theory the shunt resistance should be of the viscous type shown—a channel the length of which is relatively large with respect to its cross section dimensions—rather than the orifice type. With this method there is no power loss as long as there is no external load, and the loss that does occur is roughly proportional to the load.

Electrohydraulic Servos

Indirectly operated servo valves have been defined previously as those that employ transducers to convert input signals other than mechanical ones into mechanical displacements suitable for application to the spool of the servo valve. Amplifiers may also be used. The servos that employ such intermediate elements are known as electrohydraulic, pneumatic-hydraulic, etc., according to the nature of the input signals that result in actuation of the hydraulic output member. This discussion will cover electrohydraulic servos, although many of the comments will apply to other systems as well.

The introduction of intermediate elements into a servo system based on hydraulic actuation may be a matter of convenience or of practical necessity. In many cases the hydraulic actuating element is but the last link in a complex system involving a number of measuring and computing operations for which electrical means are the only ones worth considering. Examples are some process control systems, aircraft autopilots, and computer-controlled milling machines. In such systems the input to the hydraulic actuator is predetermined, and it is sufficient to regard the output member as a device which has to convert an electrical signal into mechanical motion, usually at fairly high power.

The essential elements of the hydraulic portion of the servo are then a power source, an electrohydraulic servo valve, and a cylinder. Servo valves are usually made with symmetrical port configurations, and if the system as a whole is required to exhibit the same characteristics in both directions, the cylinder theoretically would also have to be symmetrical, i.e., have a piston rod at both ends as in *Fig.* 64, 65, 67, and 68. In practice, however, unless the ratio of rod to cylinder diameter is unduly high, single-end cylinders should be usable in

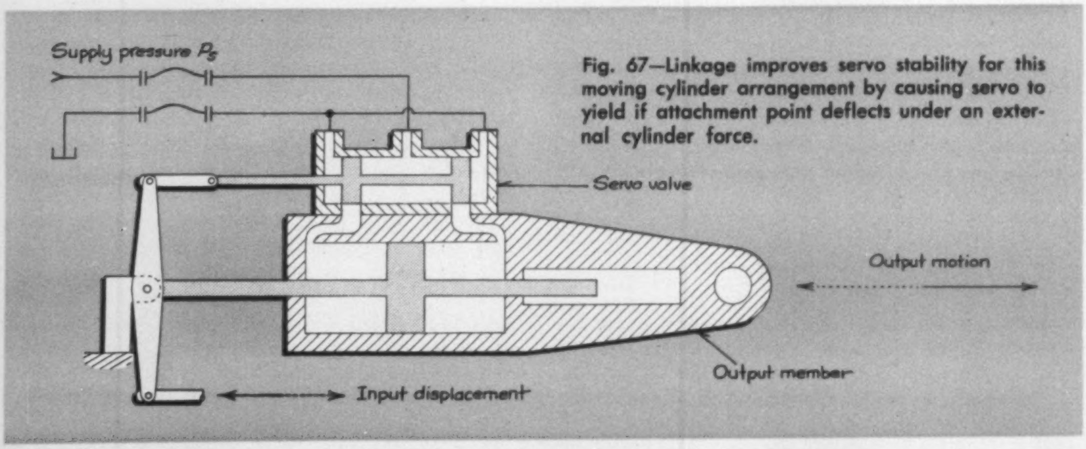


Fig. 67—Linkage improves servo stability for this moving cylinder arrangement by causing servo to yield if attachment point deflects under an external cylinder force.

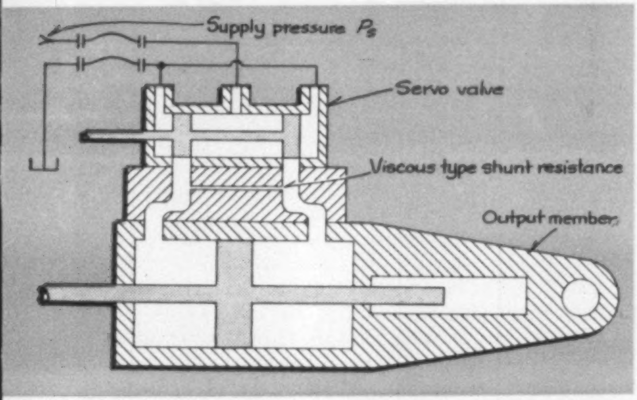

Supply pressure P_s
Servo valve
Viscous type shunt resistance
Output member

Fig. 68—Viscous shunt resistance across cylinder ports stabilizes servo with less power loss than for alternate method using a valve having underlap. With method shown, power loss is roughly proportional to load.

most cases. An alternative would be to use a servo valve having unsymmetrical port areas.

In some cases a rotary hydraulic motor may be called for instead of a cylinder. One reason for its use may be to minimize elasticity effects due to oil compressibility, since the volume of oil contained in such a motor is very small. Offsetting this, however, is the fact that inertia effects could become serious when high speeds are involved.

▶ Velocity and Position Control

The input to the hydraulic actuator may be a demand for a given displacement or for a given velocity. An input to a servo valve of the usual type will produce a corresponding and at least roughly proportional velocity of the cylinder or other motor. If no feedback is present the actuator will act as an integrating stage.

If accurate proportionality is required between a velocity demand signal and the resulting output member velocity the servo can be equipped with a velocity feedback transducer and an amplifier, *Fig.* 69(*a*). In this case a tachometer generator is used as the transducer.

If the requirement is for a given displacement instead of velocity, the output member is usually equipped with a position feedback device, *Fig.* 69(*b*), which may be a potentiometer or a synchro feeding to an amplifer.

The choice between position feedback and integrating action is often a matter of convenience, as it may be possible to alter the demand signal and thus obtain the desired characteristics for the over-all system by either method. In process controls, for example, the complication of position feedback devices can be avoided and positioning action obtained by differentiating the input signal by means of simple passive electrical networks.

The size of a servo valve is dictated by the maximum flow demand, i.e., by the required size and

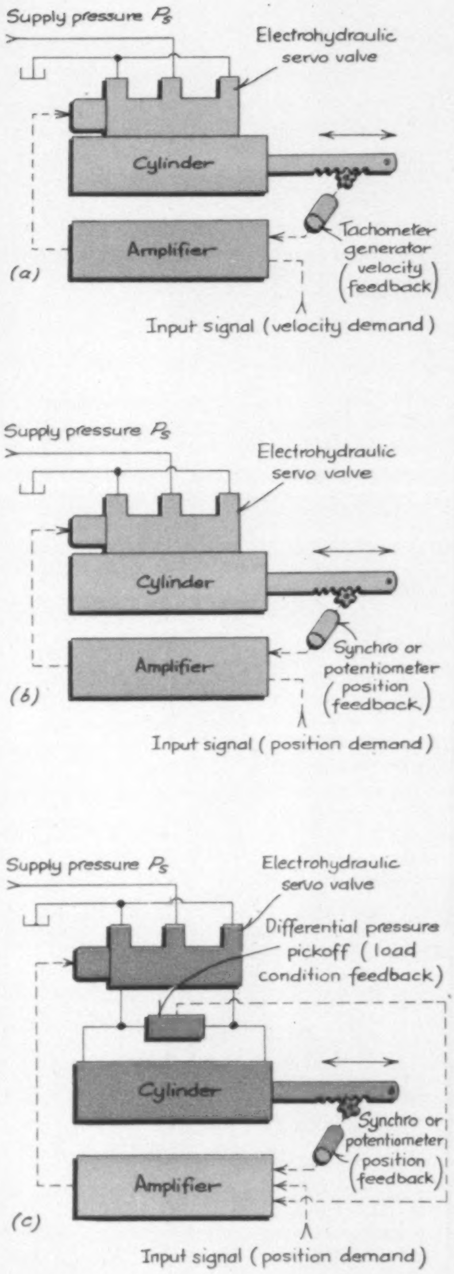

Supply pressure P_s
Electrohydraulic servo valve
Cylinder
Amplifier
Tachometer generator (velocity feedback)
(a)
Input signal (velocity demand)
Supply pressure P_s
Electrohydraulic servo valve
Cylinder
Amplifier
Synchro or potentiometer (position feedback)
(b)
Input signal (position demand)
Supply pressure P_s
Electrohydraulic servo valve
Differential pressure pickoff (load condition feedback)
Cylinder
Synchro or potentiometer (position feedback)
Amplifier
(c)
Input signal (position demand)

Fig. 69—Three methods of applying feedback to electrohydraulic servos. Velocity feedback provided by tachometer generator improves proportionality between velocity demand signal and actuator velocity *(a)*. Position feedback device in the form of a synchro or potentiometer enables use of servo for position control *(b)*. Feeding back a signal proportional to cylinder differential pressure stabilizes an electrohydraulic positioning servo *(c)*.

maximum velocity of the cylinder. If a valve of the indicated size is not available a larger valve can often be specified and operated below its maximum flow rating. Care must be exercised, however, since operation of hydraulic components under conditions that utilize only portions of their capacities can emphasize their nonlinearities and other undesirable characteristics to the detriment of system performance.

An alternate solution would be to reduce system pressure, if this is feasible on other grounds, which would mean larger cylinders and higher flow demands so that the larger valve could be used to full capacity. Before doing this the designer should consult the manufacturer to determine if the valve will operate satisfactorily at the lower pressure.

After a suitable valve has been selected an electrical or electronic amplifier is specified that will provide the desired servo gain.

Stability problems for electrohydraulic position servos are much the same as for directly operated servos previously discussed, even though they may be the last link in a long chain. With electrical position feedback the effects of elasticity of the cylinder attachment point need not be as serious, but neither is it so easy to compensate for them as with the mechanical linkages of *Fig.* 65 and 67.

Other common methods of stabilizing a servo are still applicable, however, and in particular a shunt resistance as in *Fig.* 68 may be beneficial. Another method applicable to a local hydraulic loop is use of pressure feedback, *Fig.* 69(c). This involves feeding back a signal proportional to cylinder differential pressure, which is a rough gage of cylinder load. Usually an amplifier is required.

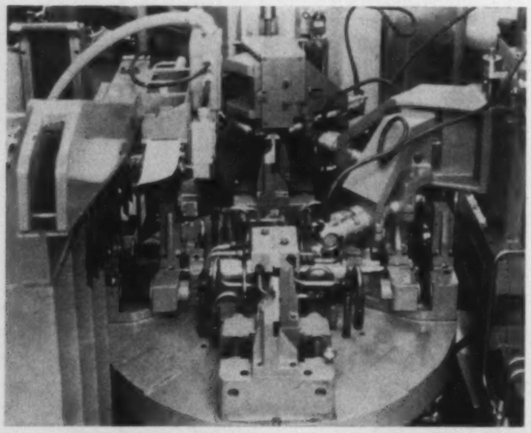
Stability problems of the complete loop must be investigated separately and on their merits.

REPRINTS

This article concludes the seven-part series on the synthesis of systems for hydraulic control of automatic machinery. In response to readers' requests, the entire series will be reprinted in booklet form, available at $1.00 per copy from Readers' Service Dept., AUTOMATION, Penton Bldg., Cleveland 13, O.

three-dimensional template control

CRITICAL manufacturing requirements for jet engine components have led to the design of numerous special machine tools and manufacturing techniques that can be adapted by a wide range of industries. An example is the three-dimensional template controlled milling machine developed by Tri-Ordinate Corp. for the purpose of milling four feather edges on the root sections of previously broached or contour ground compressor blades.

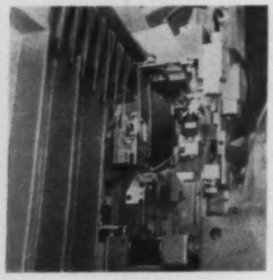


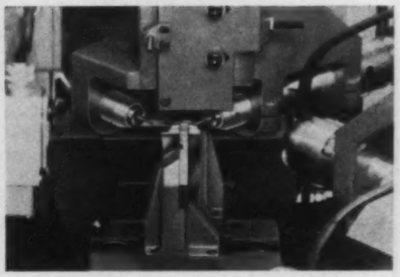
The machine replaces a manual beveling operation, requiring approximately 2 minutes a blade, by an automatic operation that turns out blades at a rate of one every 18 seconds. Blades are loaded, root end up, on a gravity conveyor which feeds them to a positioning station where they are automatically transferred by a vertical reciprocating device downward into one of four fixtures mounted on an indexing table. Blades are positioned to an accuracy of 0.0002 inch.

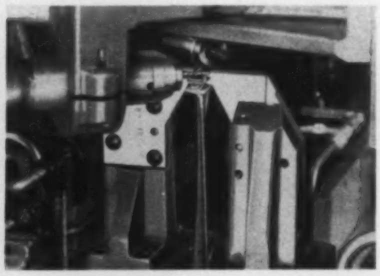
The index table rotates clockwise to position a blade before two end mills driven at 45,000 rpm. The spindles move across the blade in one pass to mill the two contoured edges of the root section nearest to the center of the indexing table.

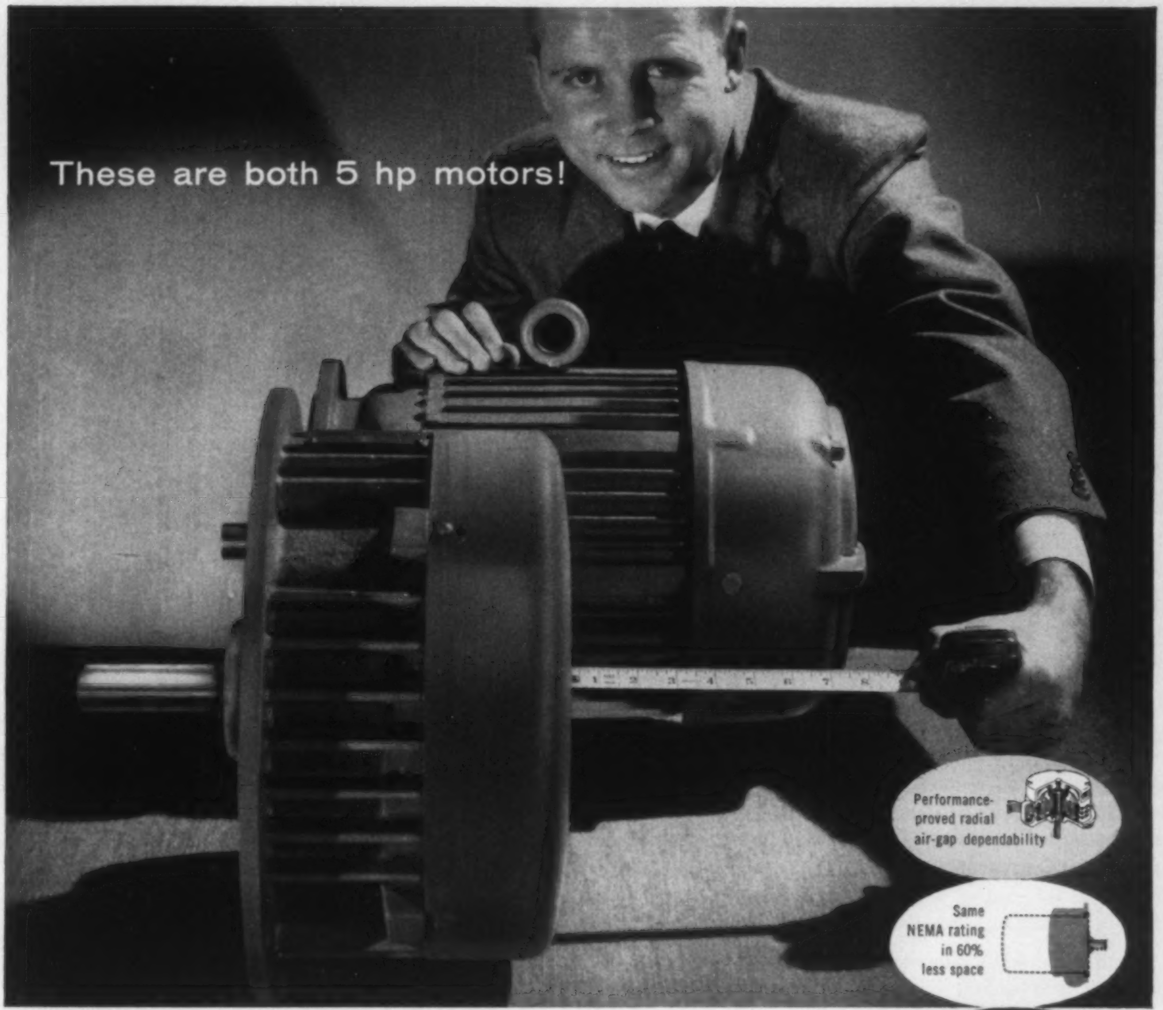
At the next workstation, another two end mills, placed in a mount that overhangs the indexing table, mill the remaining two edges of the root section. The blade is then indexed to the fourth, or unload, station where it is released to a rubber lined chute.

The technique of mounting three templates on one slide to obtain simultaneous related motion in 3 planes for a cutting tool can be economically adapted to many contouring problems involving high or moderate production with close contour tolerance.





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Circle 674 on Page 131

Courtesy Mount Wilson Observatory

FROM BEYOND THE SKY TO BENEATH THE SEAS

In the field of communications, two extraordinary events have occurred within a short span of time. One was the linking of Europe to America by the submarine telephone cable. The other was the sending of radio signals from U. S. satellites in outer space.

Both achievements depended on developments from Bell Telephone Laboratories. The cable was made possible by development of long-life electron tube amplifiers able to withstand crushing pressure on the ocean floor. The satellites derive their radio voices from transistors—products of basic research in semiconductor physics.

The deep sea amplifier and the transistor illustrate the wide range of work at Bell Telephone Laboratories. Here, over 3000 professional scientists and engineers explore and develop in physics, mathematics, electronics, chemistry, mechanical engineering, even biology—in every art and science which can help improve electrical communications.

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BELL TELEPHONE LABORATORIES

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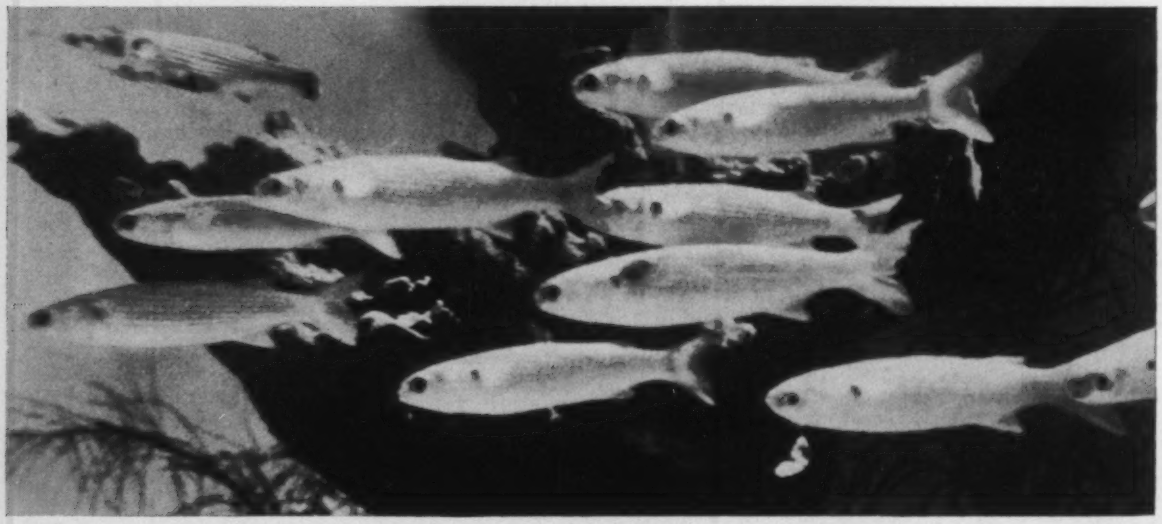
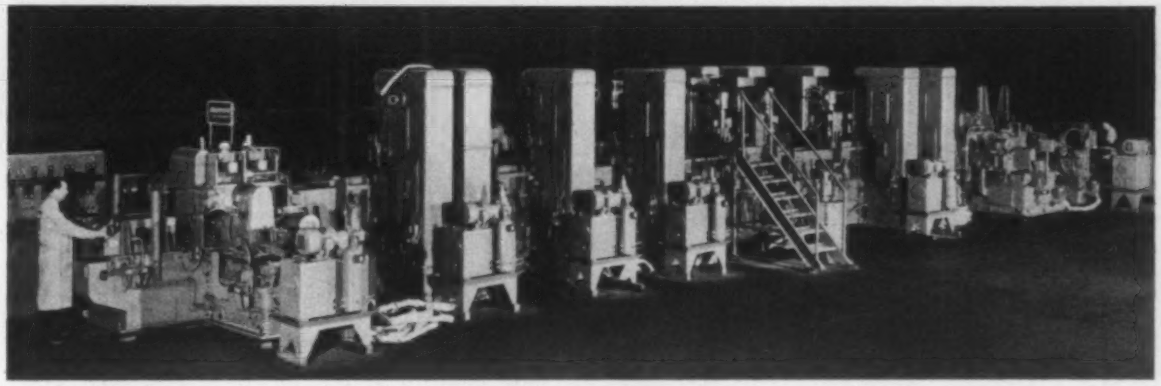


AUTOMATION new equipment

Machines and plant equipment for more automatic operations
For detailed information and literature, use card page 131.

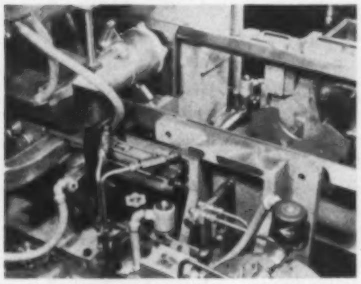


Building Block Transfer Machine Uses Static Control

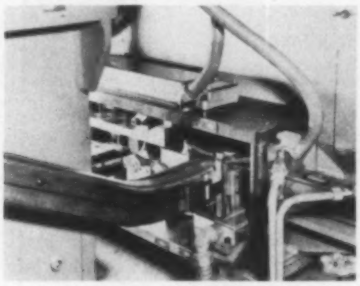
TRANSMISSION extensions are produced in large quantities on a walking-beam in-line transfer machine. Unit, designed by **Buhr Machine Tool Co.**, Ann Arbor, Mich., includes three workpiece positioners, an automatic unloader, automatic air gaging, washing, a bushing orienter, an assembly station, a spin-facing operation, and the use of static control units in the electrical circuits.

The 36-station unit (4 idle stations) can completely machine 171 aluminum die castings per hour in continuous operation. Features of the machine include an automatic unloading mechanism which removes the workpieces from the unload station, turns them large-end down and deposits them on a gravity roller-conveyor; and four blow-out and air gaging stations to prevent tool breakage and part spoilage. In operation, the air gages indicate tool condition. When parts are on tolerance, a green lamp is lit; as part dimension approaches the low limit, a yellow *Caution* lamp is lit to indicate tool wear. If parts are outside of the tolerance limits, a red light is flashed and the machine shuts down.

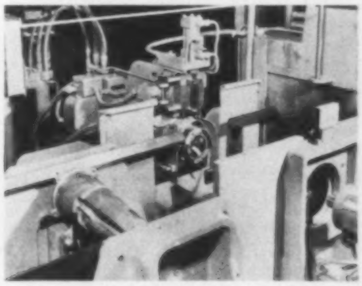
The assembly of static control units in a control panel is accomplished by plugging each unit into a socket and securing the row of units with a locking strip. The board is laid out as a large-scale



Station 27—One of three repositioners. The workpiece is revolved about its longitudinal axis to locate it for subsequent operations. A revolving arm engages a hole in the flange while the part turns in a V-type nest.



Station 28—bushings are brought to an orienting mechanism by means of a feed track. A shuttle revolves the bushing until it is oriented, then an arm drops into an opening in the bushing where a limit switch actuates a bushing-inserting ram.



Station 34—after the part is washed the transmission extension assembly is spun and the flange is faced. In this operation, the facing tool is fed down from the top. This establishes squareness of face with respect to bores.

floor plan of the machine, with indicator lights correspondingly placed to show visually the condition of all operating units. The operator does not have to refer to any other guide to find the location of trouble.

Circle 401 on Page 131

Flame Heating Machine

Item 402

Unit is applicable in operations such as spin hardening, spot hardening, progressive hardening, combination hardening, tempering, annealing, and brazing. Machine is a "building-block" type, has a wide, flat top plate where different work holding units and flame heads can be mounted. The base houses a quench tank, heat exchanger, quench agitation system, and automatic parts removal conveyor.

In the operation shown, the machine is simultaneously spot-hardening the cup and pad sections of automotive rocker arms, six at a time. Heating cycle is automatic; at the completion of the cycle, the parts are dropped into the quench tank. A built-in conveyor removes finished parts from the quenching medium.

Also available is a rotary spindle unit which permits the machine to process parts such as gears, shafts, and cams that are best handled by rotating them during the heating cycle. Spindle speeds are infinitely variable from 15 to 375 rpm. Automatic spindle retraction, up to a maximum of 10 inches, drops the workpieces into the quench tank at the completion of the heating cycle. A remotely mounted radiation pyrometer measures surface radiation from the workpieces to terminate the heating cycle when the desired surface temperature is reached. **Process Machinery Div., Cincinnati Milling Machine Co.,** Cincinnati 9, Ohio.

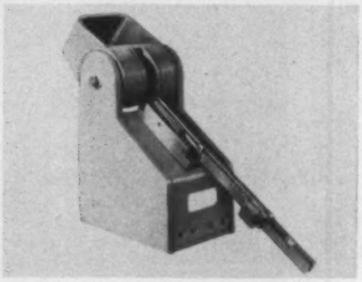
Circle 402 on Page 131

Oscillating Hopper

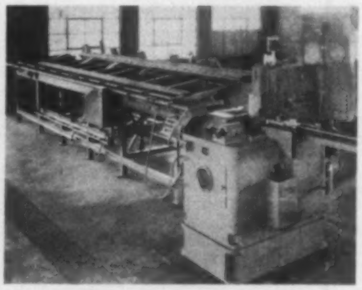
Item 403

Device is adaptable for feeding preselected quantities of small parts at the rate of approximately 125 pieces per minute. It is suitable for loading screw cartridges for automatic screw drivers and for packaging small products. The hopper track will accommodate approximately ninety #8 screws. Unit is rated for 115-230 v, 60 cycle, single phase ac.

A barrel hopper, also available, is designed for high-volume feeding of screws and small parts to automatic machines. It can handle screw sizes from #2 to ⅜-inch in lengths up to 3 inches. Device is rated for 220-440 v, 60 cycle, 3 phase ac. Ball bearing equipped motor, is ½ hp, operates at 1725 rpm. **Power Tools Div., Illinois Tool Works,** 2501 N. Keeler Ave., Chicago 39, Ill.



Circle 403 on Page 131

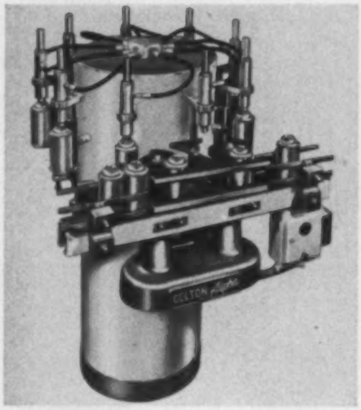


Loader & Feeder

Item 404

Automatic device eliminates manual handling of stock lengths of tubing and round stock. Loader and feeder can hold 15,000 lb of material and feed the entire load through the machine automatically. It is applicable wherever tubing or round stock is processed through other machines. In application shown, device is feeding tube to a tube cutoff machine. **Grieder Industries Inc.,** Bowling Green, Ohio.

Circle 404 on Page 131



Rotary Pressure Filler

Item 405

Device is designed to fill aerosol-type containers with different kinds of liquid propellants such as butane and propane hydrocarbon types. This operation follows the product filling, dispenser valve insertion, and valve-crimping operations. Production rate is up to 200 cans per minute. Pressure filling heads and container supports are mounted around the head at each station. A stationary cam on the base at the front of Model 1651 raises and lowers the filling head nozzles into and out of contact with the containers.

In operation, containers are removed from the conveyor line one at a time by an index wheel and placed on the container supports on the rotary head. The filling head nozzles are lowered to contact the containers which are filled under pressure as they travel with the rotary head. The containers are placed back on the line by another index wheel after filling. Machine is adjustable to handle containers ranging from 3 to 16-oz capacity.

Raising the filling head and removing the container causes the filler head to fill with propellant for the next filling cycle. During the refilling of each filler head, an internal piston is raised to a positive stop to assure container fill accuracy. If no container is placed in a station, the filling operation will not occur. **Arthur Colton Co.,** 3400 E. Lafayette, Detroit 7, Mich.

Circle 405 on Page 131

"УДИВИТЕЛЬНО!"*

CONTROL is first! Now—one step static control with switching reactors

No wonder Nikita looks worried. CONTROL has taken the strain off American industry's pocketbook by cutting the cost of static control.

American engineers who want to make free use of power switching guided by digital logic can now take over, because CONTROL's standard line of switching reactors give freedom of design and economy never before available.

First, one-step static control with switching reactors is so easy to operate it can be put to work in everyday sequencing and switching problems involving either a-c or d-c loads. Auxiliary equipment is eliminated by the basketful. Gone are all the preamplifiers, special power supplies, information-sorting single purpose logic units, and power switching relays. CONTROL's one-step switching reactor does most of the job by itself.

Second, these units, in four nominal volt-ampere ratings of 15, 75, 150 and 300, have no relay contacts or moving parts to replace. Switching is by impedance change. Install them and forget them—no wear, no maintenance.

Third, each CONTROL reactor performs all logic functions—AND, OR, NOT, MEMORY and TIME DELAY—through its multi-purpose control coils. Signal source is derived typically from limit switches, push buttons, or photo-cells.

Fourth, each unit has a 10,000:1 switching ratio under nominal supply voltage conditions. High inrush currents are handled without difficulty.

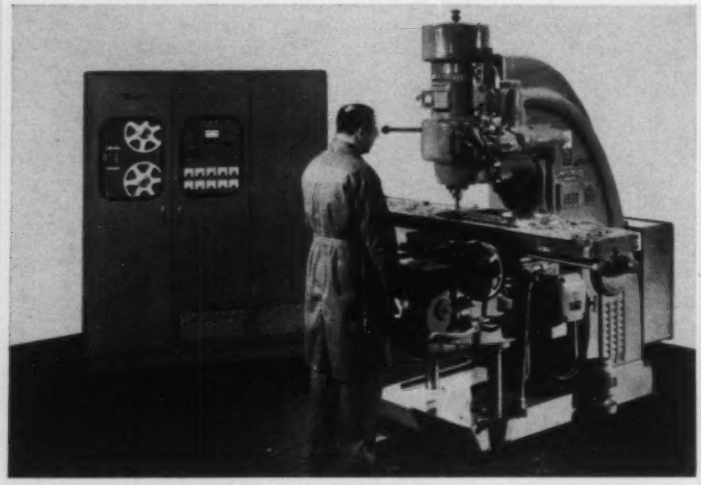
To learn how CONTROL reactors work, and how they'll fit your need for completely dependable, low-cost, versatile static control, write—and see why Nikita looks worried. *CONTROL, Dept. A-46, Butler, Pa. U. S. A.*

Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

**Expurgated translation. Heavens-to-Betsy!*

Circle 675 on Page 131

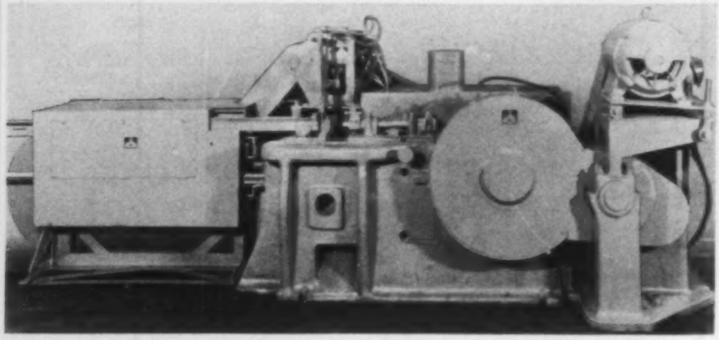


Tape Controlled Milling Machine

Item 406

Numerically controlled knee type milling machine is available in three standard models. Model 2CH-KTNC has 5 hp drive with 16 spindle speeds ranging from 25 to 1500 rpm. Model 315TF-KTNC and Model 415TF-KTNC are heavy-duty 15 hp units, with twin elevating screws and 24 spindle speeds ranging from 15 to 1500 rpm. Power for short feed motion is transmitted through low-friction, recirculating ball screws. Three different control systems are available, choice depending on the application. **Kearney & Trecker Corp.**, 6784 W. National Ave., Milwaukee 14, Wis.

Circle 406 on Page 131



Automatic Upset-Forging Machine Line

Item 407

Upset-forging machine is available in sizes of $1\frac{1}{4}$-inch to 5 inches. Model XN (shown) is a $1\frac{1}{2}$-inch size capable of producing up to $\frac{3}{4}$-inch diameter square or hex head bolts in lengths to 24-inches at a rate of 60 bolts per minute. In operation, precut and heated material is fed into a receiving chute on the machine. These parts are then gaged, picked up by fingers, and passed progressively through the dies. While the material is being moved from pass to pass, it can be rotated 90 degrees to assure a uniform forging. A finished upset forging is produced with every revolution of the forger. Short parts drop through the bottom opening, and long parts are ejected at the rear of the machine. **Hill Acme Co.**, 1201 W. 65th St., Cleveland 2, Ohio.

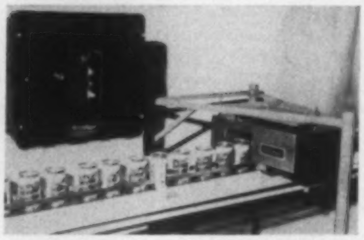
Circle 407 on Page 131

Inspector/Ejector Unit

Item 408

Applicable in food processing, brewery, petroleum, and chemical packaging, equipment accurately measures the height of filled material in individual tin cans or other containers moving on a conveyor line. It automatically actuates an ejecting device to remove any container from the line in which the fill height does not conform to specifications. System can be installed on a production line before or after capping operations.

On a conveyor line where liquids are being processed, the system has an accuracy of ±1/64-inch of target fill level in each container. It is usable at machine speeds of 1000 containers per minute. Unit includes a measuring head and a control unit. The measuring head has an isotope energy source and detector.



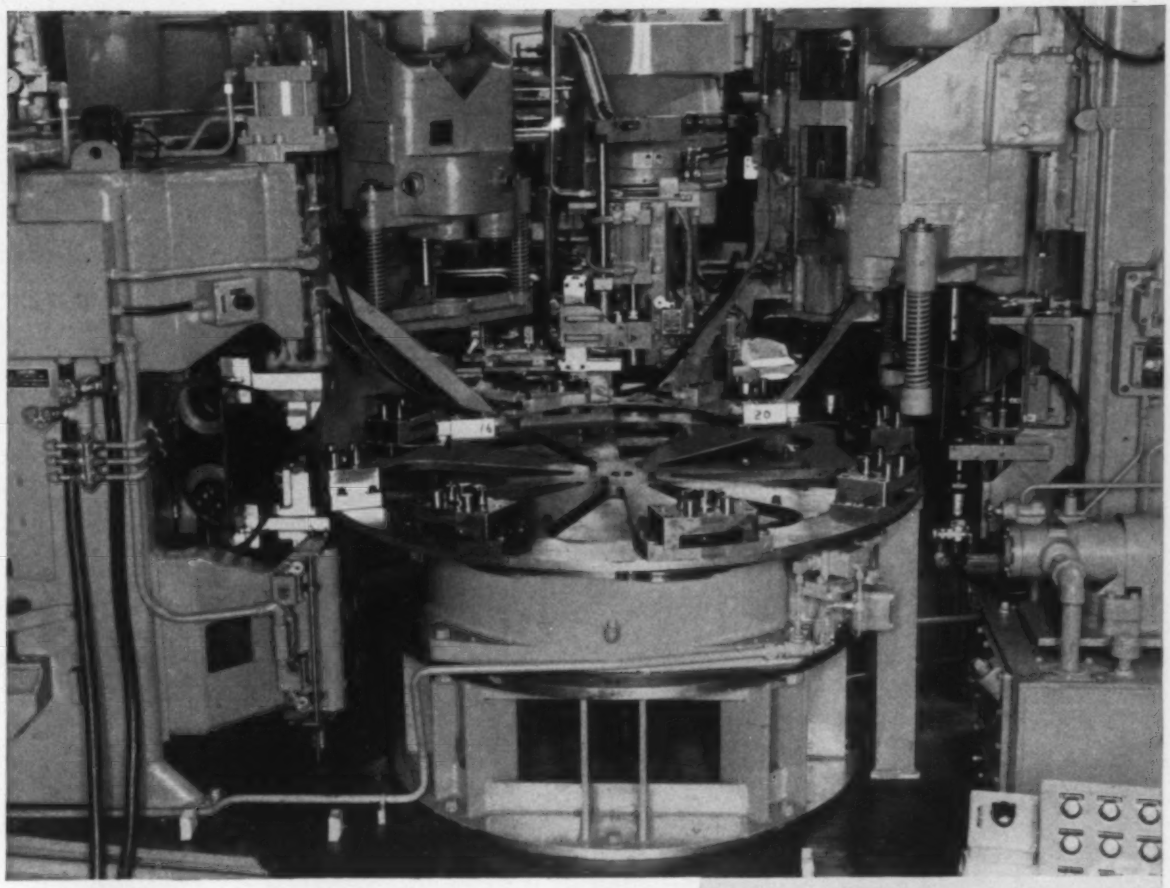
In operation, containers to be inspected pass under the measuring head and small changes in individual fill height produce variations in the amount of energy passing from the isotope source to the detector. These variations are translated into corresponding voltages by the detector and fed into the control unit. The control measures the voltage received from the detector and generates a signal whenever the incoming voltage is outside preset limits. This signal then energizes mechanical or pneumatic devices to remove the improperly filled can from the conveyor line. **Industrial Nucleonics Corp.**, 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle 408 on Page 131

Overhead Conveyor

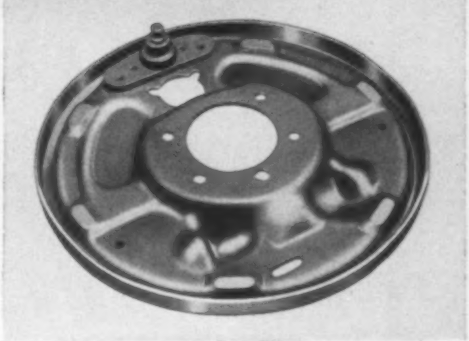
Item 409

Suitable for light duty service, Model 232 is capable of handling parts of various sizes and shapes. In painting and drying applica-



THIS NATIONAL ELECTRIC MULTI-STATION DIAL FEED MACHINE

paid for itself in **9** *months!*



52

Loading, resistance welding, hydraulic reaming, hopper feeding, pressing, hot upsetting and hollow milling are the seven operations—performed automatically—on automotive brake backing plates by this one National Electric Dial Feed Machine. The installation of this unit, by an automobile manufacturer, not only released eight machines for other production, but saved a corresponding amount of floor space as well.

This is only one example of the money and man-hour savings realized when National Electric Automatic Welding Machines are employed. National Resistance Welders, Gas-shielded Arc Welders and Submerged Arc Welders . . . meet the high-speed assembly-line methods and close tolerances demanded throughout American Industry. A National Electric Welding Machine can be developed to fill requirements of any volume welding job. Write today for information.

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1870 N. TRUMBULL STREET
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25 YEARS EXPERIENCE DESIGNING AND BUILDING: SPECIAL & STANDARD • AIR • HYDRAULIC • MOTOR DRIVEN • SPOT • PROJECTION • SEAM • BUTT • FLASH • RESISTANCE WELDERS • PRODUCTION FIXTURES FOR ALL TYPES OF AUTOMATIC ARC WELDING.

tion (shown), overhead trolley conveyor is 664 feet long, moves at approximately 10 feet per minute, with a maximum capacity of 5000 pounds of parts.

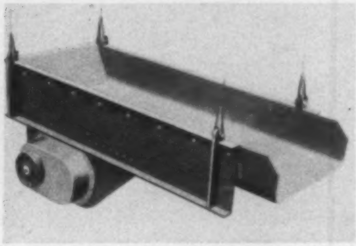
Junior T truck is easily installed. Standard vertical bends are made in 2, 4, and 6 feet radii, sprocket turns are available in 30, 45, 60, 90, and 180 degree units. Sprocket drive units have capacities ranging from 350 to 750 lbs with horsepower ratings from $\frac{1}{4}$ to 2. Conveyors can be driven at speeds ranging from 1 to 50 fpm. **Mathews Conveyor Co.**, Ellwood City, Pa.

Circle 409 on Page 131

Vibrating Feeder

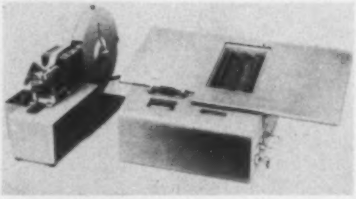
Item 410

Device can feed a wide variety of bulk materials at high rates. Mounted directly under a hopper or bin, unit can feed, convey, pick, or scalp high tonnages of materials, including lumps up to 36 inches in diameter. Speed of the vibrator can be changed by adjusting a variable speed belt drive; the hopper gate can be adjusted to control material depth; and the horizontal stroke can be adjusted to control material trajectory. Vibrator's stroke is from $\frac{1}{4}$ to $\frac{1}{2}$-inch at 900 rpm. Feeder can be floor supported or suspended by cables from bins or tanks. Optional components such as dust-tight covers and scalping decks are available.



A line of feeders of this basic design, but incorporating a motor integral with the vibrator drive, is also available. **Link-Belt Co.**, Dept. PR, Prudential Plaza, Chicago 1, Ill.

Circle 410 on Page 131



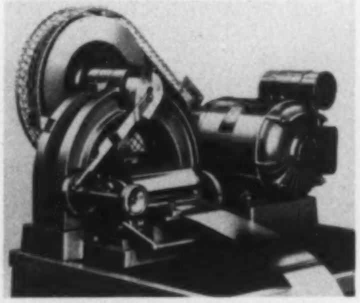
Data Processor

Item 411

Instrument is applicable in accounting, payroll, inventory, and production control. Device accepts fixed data from tabulating or edge-punched cards and variable data through a keyboard. The two data inputs are automatically combined and punched out on tape. The tape output can be fed directly to a computer, or to a tape-to-card converter for use in any tabulating machine or system. It can be used with magnetic tape, drum, and core systems.

Unit consists of two separate units, an input console and a tape punch, which can be located at points distant from one another. Punched cards used in the processor to supply fixed data can be reused indefinitely. This feature cuts down on the storage requirements for cards. Operation of the processor does not require a highly trained operator. **Taller & Cooper Inc.**, 75 Front St., Brooklyn 1, N. Y.

Circle 411 on Page 131



Bench Press

Item 412

Machine is driven by a $\frac{1}{2}$ hp motor. Speed is 180 strokes per minute and capacity is $2\frac{1}{2}$ tons. The top of the frame has a crankshaft with a fixed stroke of $\frac{1}{2}$-inch. The con-

How fast do you want to drill...
10,000 RPM
MAYBE
15,000 OR
20,000 ?
US DRILL HEAD
Oil-circulating head with vertical adjustment spindles.

U. S. Drill Heads are designed to drill as fast as you need—*and still maintain accuracy!*

The rugged Fixed Center Head shown is a full ball bearing, oil-circulating model with built-in pump. It operates regularly in production at 15,000 rpm with very little heat! As in all U. S. Heads, shaved gears assure quiet, smooth operation—at all speeds. Write for catalog FC-57.

US DRILL HEAD

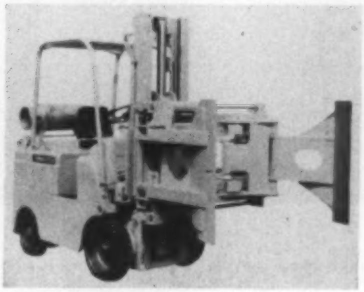
Adjustable and Fixed Center Multiple Drilling Heads.
Individual Lead Screw Multiple Tapping Heads.

UNITED STATES DRILL HEAD CO.
BURNS STREET • CINCINNATI 4, OHIO

Circle 677 on Page 131

necting rod has a length adjustment of ⅝-inch for setting the working height of the upper part of the press tool. The ram is suspended on the connecting rod and is guided by the pillars of a dieset. No slides are used. A roll feed, which is operated by an adjustable throw crank, push-feeds the stock from the front of the machine. It can accommodate strip up to 5 inches wide. Depression of a rod extending across the machine at its base opens the rolls for the insertion of fresh strip or for positioning of the strip. By driving the feed from the right side, instead of the left, the feed will pull the strip through from the rear instead of pushing it from the front. **Wharton Unitools,** Valley Stream, L. I., N. Y.

Circle 412 on Page 131

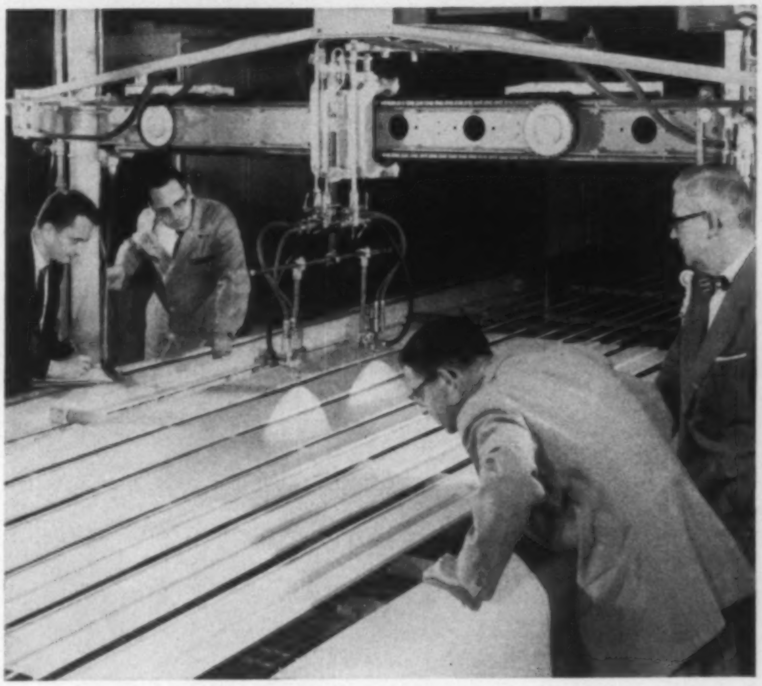


Paper Roll Clamp

Item 413

Rotating roll clamp provides safe and rapid handling of paper rolls weighing up to 3½ tons. The attachment, which is designed for use with company's lift trucks, hydraulically rotates paper rolls in either direction from a vertical or horizontal position.

Clamp is available in three models; a hydraulic type with a diameter range of 10 inches to 65 inches, and two manually adjustable types. Each model has a fixed arm and a hydraulically-actuated movable arm. Curved shoes on the ends of the arms provide a secure grip on the roll without damaging the load. The clamps can be furnished with either one or two pivoted shoes. The single-pivoted shoe provides easy handling from the horizontal position, while twin pivoted shoes are used for handling rolls that are close-packed in the vertical position, as in boxcar operations. Similar attachments are available for the han-



A test run in the DeVilbiss research laboratory lets you...

Try automatic spraying before you buy!

The only way to be sure if change-over to fully automatic spraying is the *right step* is an actual test under identical production conditions and using the exact materials you normally apply.

That's why more and more manufacturers are having us schedule trial production runs in our fully equipped research laboratory.

Working to your coating specifications, we duplicate your plant conditions in every possible way.

Then we test-run your product on the best suited standard automatic spray machine. Your supervisors are invited to be there; results are passed along to you.

Thus, you know *before* making any equipment purchases or shop modifications if it will pay you to spray automatically!

To arrange a test run, contact your nearest DeVilbiss representative or write us in Toledo. DeVilbiss offers automatic spray machines for coating products of practically any size or shape, and for use with most conveyor systems . . . the *only* automatics capable of spraying inside deep cavities, as well as uniformly coating exterior surfaces.

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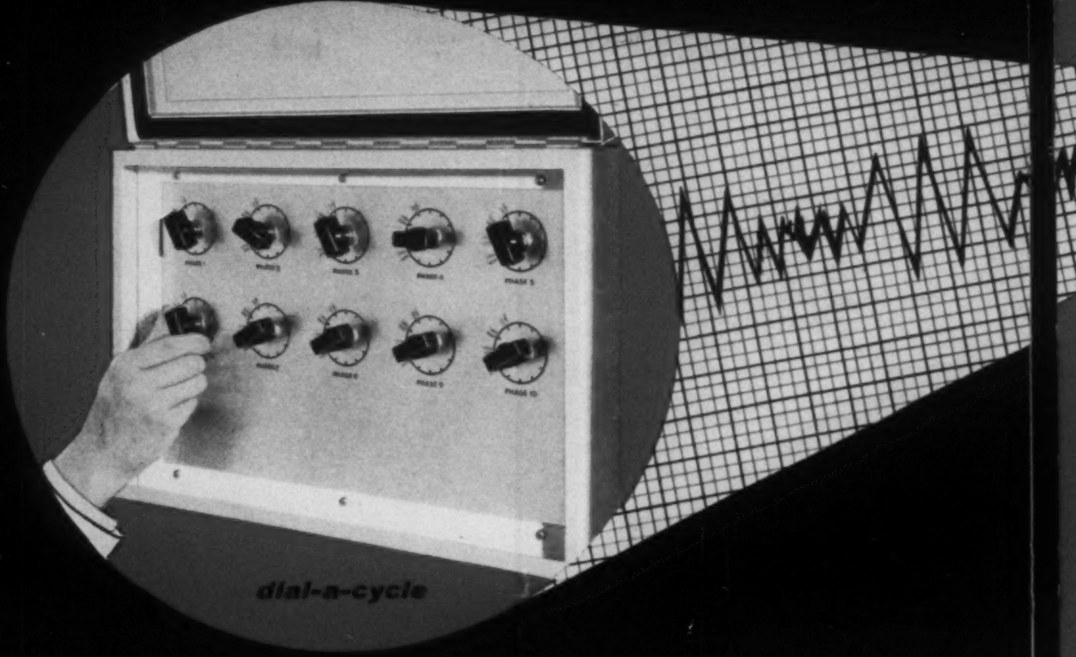
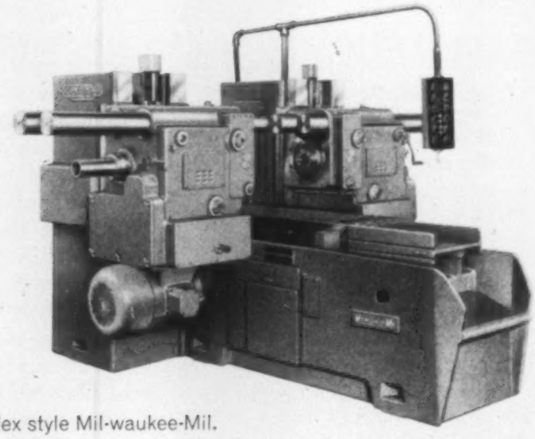
Circle 678 on Page 131



first ***dial*** *your results from the blueprint . . .*



Kearney & Trecker Duplex style Mil-waukee-Mil.

Designers and Builders of Precision
and Production Machine Tools Since 1898

KEARNEY & TRECKER
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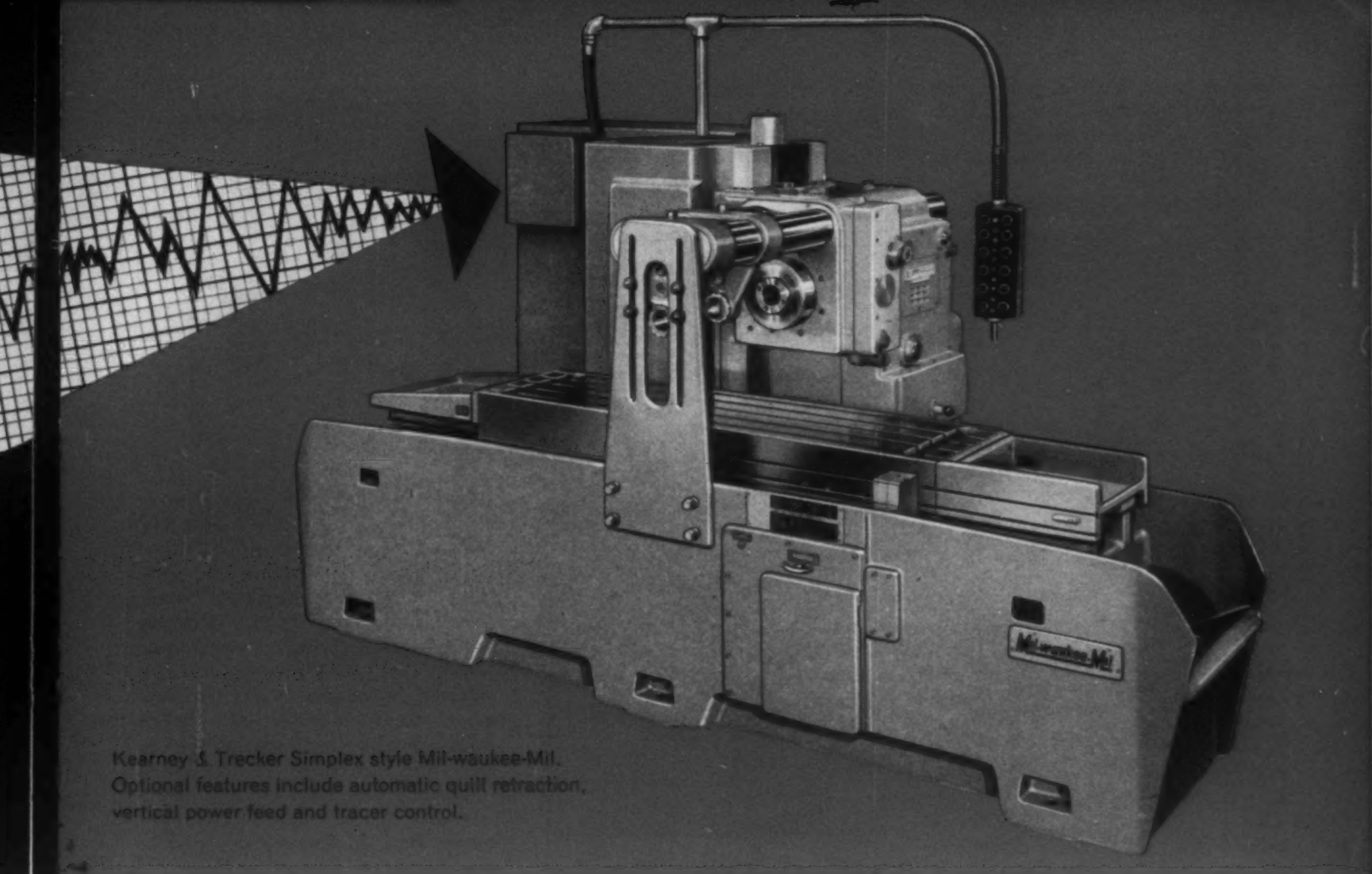


Kearney & Trecker Simplex style Mil-waukee-Mil. Optional features include automatic quill retraction, vertical power feed and tracer control.

then get programmed production ***automatically***
with the NEW ***Kearney & Trecker***

Mil-waukee-Mil® **BED TYPE**

PRODUCTION MILLING MACHINE

- ***dial-a-cycle*** **panel programs and controls each and every machine function . . . automatically!**
- **Interrupt or resume cycles at any time without returning to "start" position!**
- **Change from** ***dial-a-cycle*** **automatic control to manual with the flip of a switch!**
- **Choose from 72 standard models . . . Simplex and Duplex . . . 7½ to 30 hp.**

Fast, pre-phased setups slash idle cutter time — dramatically boost finished workpiece production. Do it on this remarkable new Kearney & Trecker Mil-waukee-Mil programmed production milling machine.

Operator simply dial-programs machine function into the ***dial-a-cycle*** control panel. No guesswork! He merely reads workpiece blueprint and establishes machining sequence with successive phase-switch dials.

Free Bulletin MM-58 —

Kearney & Trecker Corp., 6784 West National Ave.,
Milwaukee 14, Wisconsin.

Circle 679 on Page 131

dling of bales, barrels, drums, and cartons. **Towmotor Corp.,** 1226 E. 152nd St., Cleveland 10, Ohio.

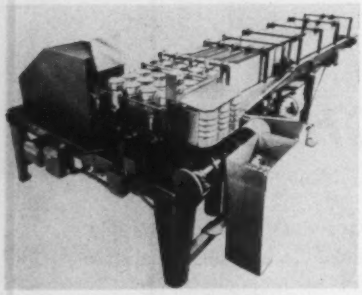
Circle 413 on Page 131

Telescoping Conveyor

Item 414

Suitable for operations where space is limited, power-driven conveyor will extend to 51 feet. Conveyor is mounted on swivel casters, can be moved to any location, adjusted to dock levels, truck beds, and boxcar floors. The headstand is equipped with a scissors jack to provide a 14-inch height adjustment, can be retracted by means of a pushbutton. Conveying element is a series of spring belts and grooved rollers with 10-inch over-all height required for each deck. Each level is individually powered. **Power-Curve Conveyor Co.,** 2185 S. Jason St., Denver 23, Colo.

Circle 414 on Page 131

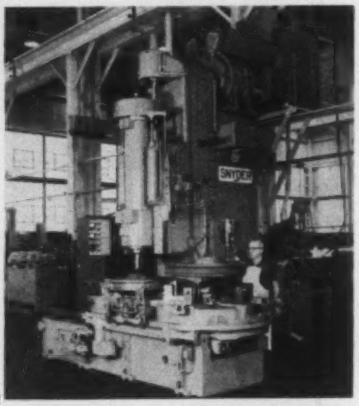


Shipping Case Loader

Item 415

Machine can load cans, in single tiers, into end-loading shipping cases. Designed for 46-oz and #10 size cans, unit is also available for smaller sizes. In operation, cans travel in an upright position on a wire mesh belt conveyor, and are carried though divider lanes into the loading chamber. When a load has been assembled, and a shipping case positioned on the loading funnel, a pusher plate automatically slides the load into the case. Production rate can exceed 1200 cases per hour. Caser is designed to eliminate incomplete loading of cases. Discharging of a tier of cans without the shipping case being in proper position is also prevented. **Canning Machinery Div., Food Machinery & Chemical Corp.,** P. O. Box 1120, San Jose 8, Calif.

Circle 415 on Page 131



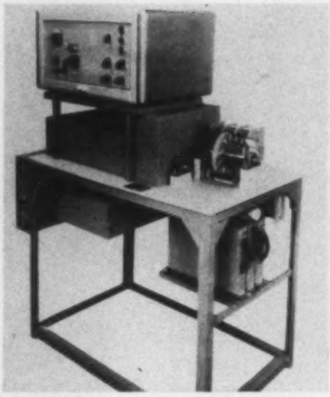
Vertical Boring Machine

Item 416

Unit is designed for fast production of heavy parts. Parts weighing up to 700 lb are loaded into a two-position, line-index type fixture while another is being bored. The spindle of the machine is powered by a variable speed drive to accommodate a variety of bore sizes. Hydraulically-operated five-jaw chucks permit holding parts of different diameters.

In the operation shown, cast or forged steel railway car wheels are semifinish bored with up to 11/16-inch of stock on a side removed from a 7-inch diameter bore in a 70 second machining operation. Wheels ranging from nominal 6⅛-inch to 7⅜-inch diameter bores are processed on the machine by adjusting spindle speeds and changing the boring bars. Two-step bars with throw-away carbide inserts bore the wheels. The tools are rotated at a surface speed of 225 fpm and fed at a rate of 1/16-inch per revolution of the spindle. **Snyder Tool & Engineering Co.,** 3400 E. Lafayette Ave., Detroit 7, Mich.

Circle 416 on Page 131

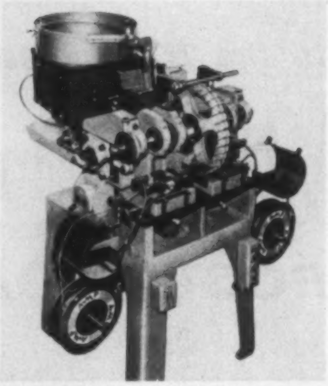


Capacitance Bridge

Item 417

Available with semi or fully automatic component feeding and sorting mechanisms, Model 1 MC is applicable for laboratory or production testing. Instrument is a self-contained unit, does not require any external capacitors. It can be used as a visual indicator with green light indicating test capacitor within tolerance, and red and amber lights indicating high or low, or out-of-tolerance units. **Industrial Instruments Inc.,** 89 Commerce Rd., Essex County, N. J.

Circle 417 on Page 131

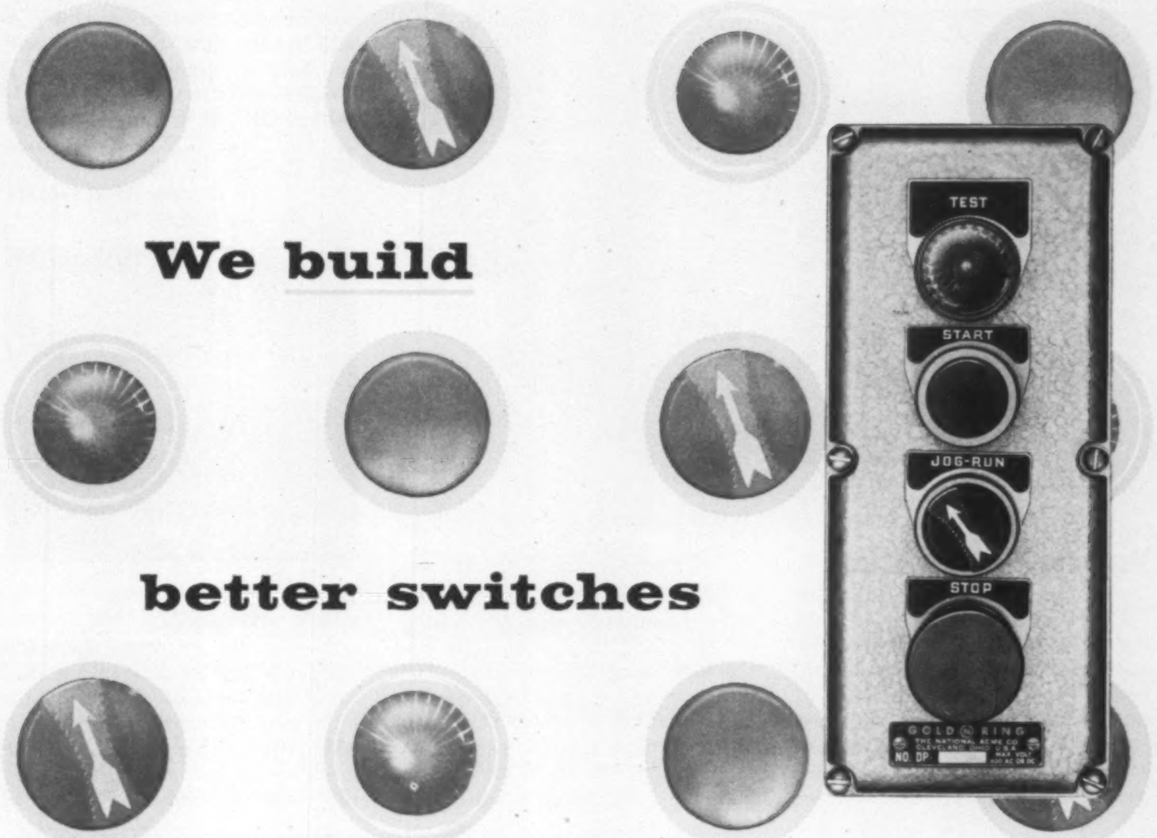


Automatic Tipping Unit

Item 418

Unit applies component tips to leads of electrical components on a high-speed production basis. The cold solder problem is prevented by tipping because there is no movement of components during the dipping cycle. The tips are suitable for joining miniature components to printed circuit boards. **AMP Inc.,** Harrisburg 34, Pa.

Circle 418 on Page 131



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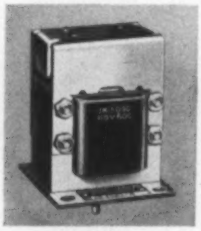
SNAP-LOCK
SWITCH

LIMIT SWITCHES. A full line, originally designed for machine tool applications but now used wherever the highest reliability factors are required. Bulletin EM-51.



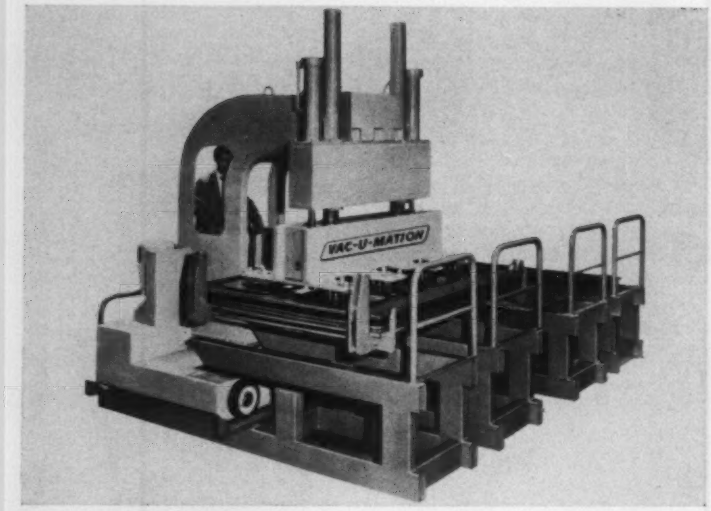
SOLENOIDS. A full line of standard and custom units for AC or DC. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A.

ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL
ACME COMPANY
196 E. 131st STREET
CLEVELAND 8, OHIO

Circle 680 on Page 131

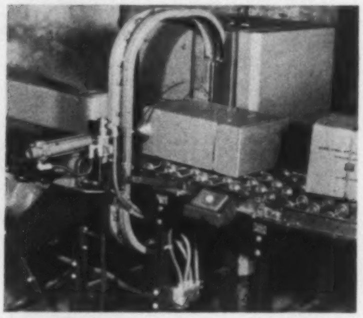


Vacuum Plate Handler

Item 419

Unit is capable of lifting and moving by vacuum, single or multiple plate loads from 2000 to 10,000 lb. In operation, a switch turns on two vacuum pumps, which in turn evacuate a safety tank. The vacuum is applied to eight 20-inch square waffle-faced vacuum cups. When a gage shows 20 to 25 inches of vacuum under the cups, the leveller can be put in the *Up* position, and the load lifted hydraulically. The load is moved along a track-way by a gearhead motor directly connected to two driving wheels mounted on the carriage. If one of the pumps fails, the other pump is capable of sustaining the vacuum. If power in both pumps fails, the safety tank can hold a maximum load for a period of 5 to 10 minutes. **Vac-U-Mation Div., F. J. Littell Machine Co.,** Dept. 6-A, 4127 N. Ravenswood Ave., Chicago 13, Ill.

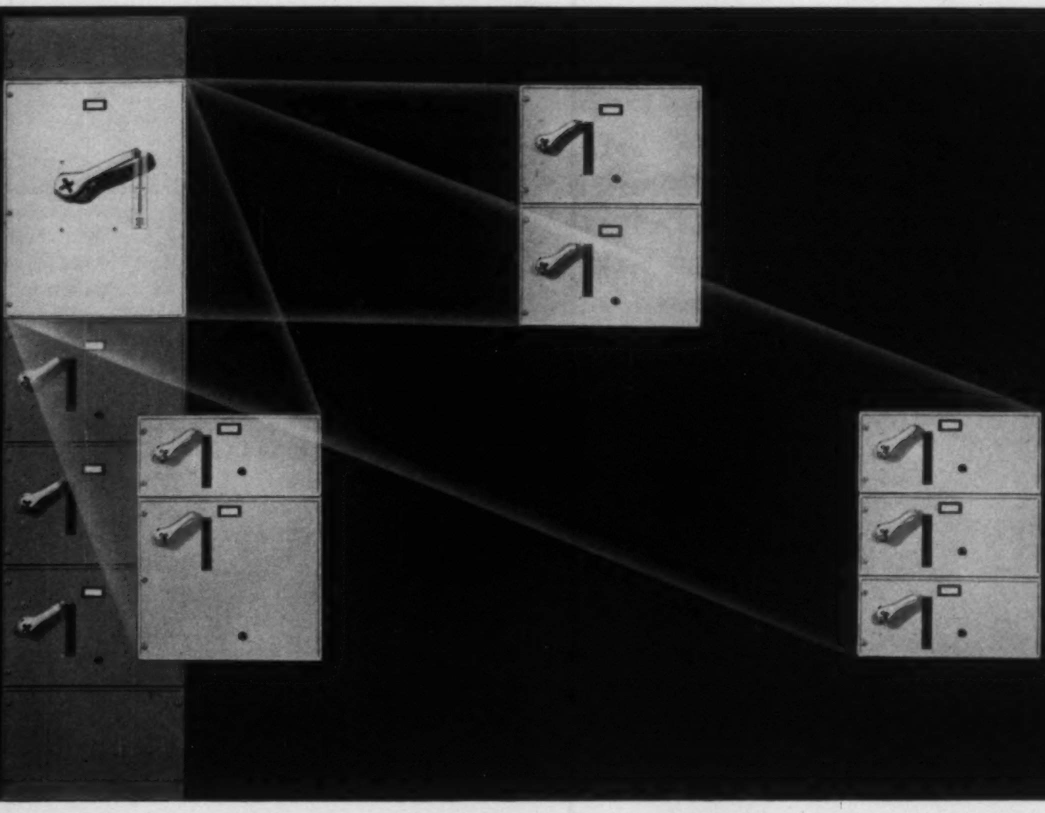
Circle 419 on Page 131



Steel Strapper

Item 420

Unit is capable of applying steel strappings automatically, with uniform predetermined tension, to a wide range of sizes of packages. The machine can be set up to supply the required number of straps in



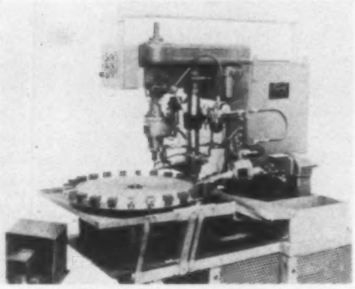
the proper places. It has automatic takeup which allows a wide range between the maximum and minimum sizes of packages strapped. In operation, as a package moves into the machine on a short length of power conveyor, the size of the package is sensed and the proper strapping pattern selected and actuated. The package is positioned by a ram located at the front of the machine. Sealed joints are made with double spot welds. **Acme Steel Co.**, 135th St. & Perry Ave., Chicago 27, Ill.

Circle 420 on Page 131

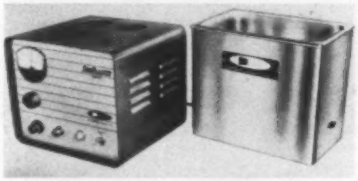
Indexing Tapper

Item 421

Automatic, two-position tapping machine includes an indexing table and two standard drill presses equipped with tapping heads. Parts are indexed into position and the tapping heads, one operating vertically and the other horizontally, are activated. To operate, a foot switch is pressed down. When the switch is released the unit stops. With proper parts-holding fixtures mounted in the index plate, a variety of parts can be tapped. Production rate is 35 parts per minute. **Automatic Methods Inc.**, 875 W. Grand St., Elizabeth, N. J.



Circle 421 on Page 131



Ultrasonic Cleaners

Item 422

Applicable in the metal-finishing and chemical process industries, line includes an ultrasonic generator (Model G-601) and transducer/tank units. Unit is capable of removing more than 35 soils common to metal, glass, plastic, ceramic, stone, rubber, leather, and paper. Equipment can also be adapted to polishing, deburring, plating, etching, anodizing, and brightening.

Line of cleaners consists of 13 different ultrasonic systems. Stainless steel tanks range from ½ gallon to one gallon capacity with single or double tank compartments. Some units feature inlet and outlet taps for hook-up to external recirculating systems; others have self-contained recirculating pumps, filters, and temperature controls. **Narda Ultrasonics Corp.**, 118-160 Herricks Rd., Mineola, L. I., N. Y.

Circle 422 on Page 131

Wire Stripper

Item 423

Prestripping the leads of self-supporting coils such as choke and circuit breaker coils wound on spring or torsion winders, is the function of Model 2086. In operation, a sig-

Westinghouse CONTROL CENTERS
feature dual-modular units
to solve your space problems

The efficient design of these new Westinghouse units is the answer to today's . . . and tomorrow's . . . need for complete flexibility in control center installations. Westinghouse control centers are ready to meet any demand for expansion or modification.

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J-22107

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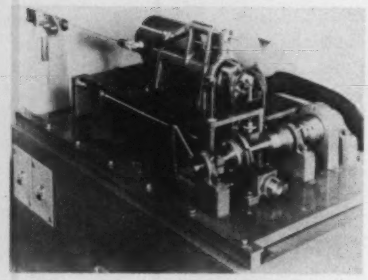
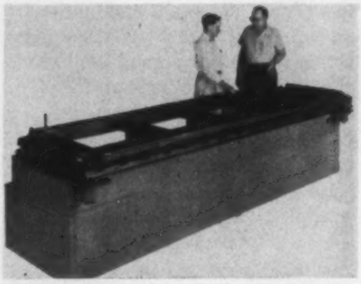
Circle 681 on Page 131



nal from a cam-operated limit switch on the winder actuates the stripped mechanism. The wire is clamped and rotating stripper-blades close on the wire. The stripper moves a preset distance along the wire, the blades retract, and the clamps open to release the wire for the next winding operation. The stripper then returns to its starting position. Smallest wire which can be stripped is AWG #24; largest wire is AWG #14. **Eraser Co. Inc.**, 1068 S. Clinton St., Syracuse 4, N. Y.

Circle 423 on Page 131



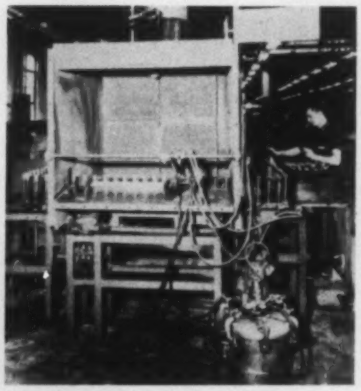
Chain Indexing Chassis

Item 424

Standardized bases are designed for indexing tooling applications, such as feeding, machining, fastening, inspecting, packaging, and ejecting. Two different models are available. The OT Series (shown) indexes parts carriers around a base, while the OU Series indexes parts carriers over and under a base frame. Indexes of $1\frac{1}{4}$ to $11\frac{1}{4}$ inches at rates to 1500 indexes per hour are standard.

A cam shaft connected by chain to the drive unit furnishes an accurate method of timing electrical, pneumatic, and mechanical work operations during the indexing and dwell periods of cycling. An automatic adjustable torque safety clutch, and a manual device to disengage the carrier chain, provide smooth operation. **Benerson Corp.**, 1319 W. Florida St., Evansville, Ind.

Circle 424 on Page 131



Automatic Spray Booth

Item 425

Equipment is designed to spray small parts such as spark plug insulators, plastic parts, metal parts, and hub caps. Production rate is up to 6000 parts per hour depending on the size. In the operation shown, rock drill bits are painted at a rate

TRUE-TRACE
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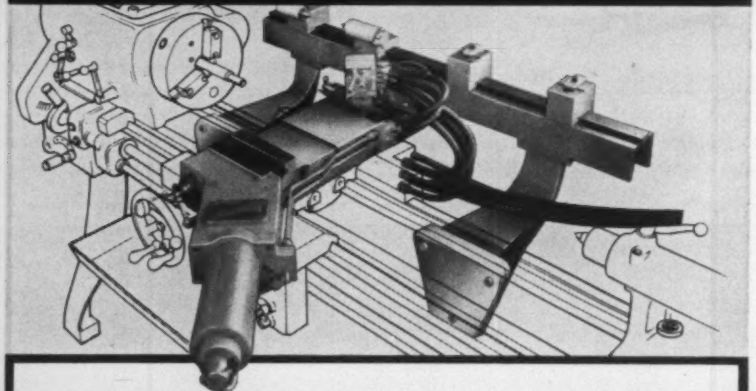

The all new *True-Trace* Single Dimension, 45° hydraulic lathe tracer attachments are specifically designed and engineered to convert standard engine lathes to modern contour turning machines. *True-Trace* precision controls and unique features permit relatively unskilled labor to produce a greater volume of parts, more accurately . . . at less cost! Whatever your job or requirements, let *True-Trace* show you how to get more from your present lathes with a tracer attachment.

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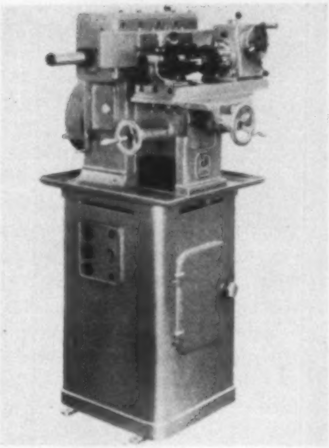
DEALERS IN PRINCIPAL CITIES

Circle 682 on Page 131

of 3500 per hour.

Machine consists of a spray booth which can be equipped with either a dry type or water wash type filter. In operation, parts move through the spray booth on spindles attached to a roller chain which is powered by a variable speed drive. A variable speed friction belt drive independently rotates the spindles as they pass the spray station. The chain which carries the parts past the spray station can be routed in any direction after leaving the spray booth. This chain can be used to carry the parts through a drying oven or deliver them to the packing area. **Schweitzer Equipment Co.**, 3764 Ridge Rd., Cleveland 9, Ohio.

Circle 425 on Page 131

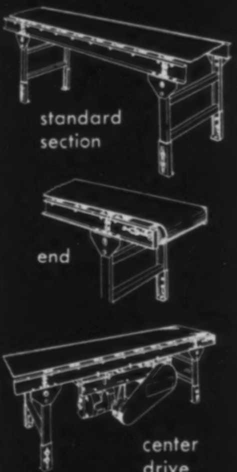


Punch Shaper

Item 426

Machine makes irregular shaped stamping and electrode punches of high precision, ±0.00025-inch. A larger dividing head with automatic circular feed permits the machining of radii and angles automatically. No further machining operations are needed with Model K-150; all workpieces are clamped directly in a collet holder between centers, or to the co-ordinate chuck. The chuck and indexing attachment guide the workpiece along the contour with one chucking. A built-in 30 power microscope checks all machining operations in the shaping process. **Jersey Mfg. Co.**, 412 Livingston St., Elizabeth 1, N. J.

Circle 426 on Page 131



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Circle 683 on Page 131

GREENLEE TRANSFER MACHINES

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THIS MACHINE HAS BEEN REWORKED FOUR TIMES

The "building block" idea of machine tool design has gained much popularity in recent years. Greenlee has long built such flexibility into their transfer machines. For example, the machine shown here has been modified 4 times in 11 years to accommodate changes in product design. Protect yourself from costly obsolescence. Ask Greenlee to show you how.

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Circle 684 on Page 131

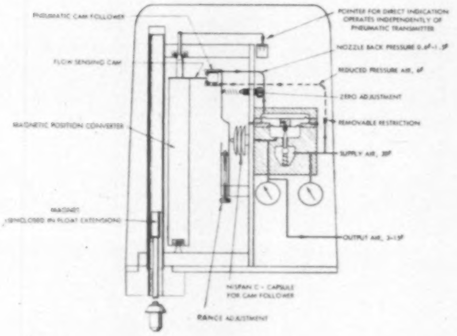
AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 131.

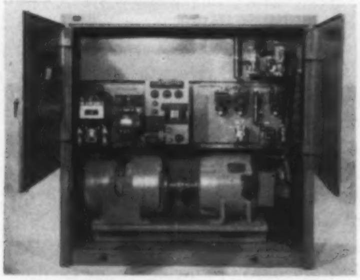
Flow Rate Transmitter

DESIGNED by **Brooks Rotameter Co.**, Lansdale, Pa., as a "building-block" device, unit can function as a pneumatic transmitter for recording, control, or integration of quantities represented by a linear motion. Method used in the transmitter consists of a magnetic iron strip formed into a helix and encapsulated in a nonmagnetic stainless steel tube which floats between two stainless steel, miniature bearing races. The helix assembly is located parallel and adjacent to a stainless steel rotameter extension tube. A metering float extension, with a small magnet embedded in it, moves within the tube in direct response to flow rate changes. The leading edge of the helix is constantly attracted to the magnet, turning to convert a linear motion into a rotary one. A pointer mounted on top of the helix assembly indicates flow rate.


PNEUMATIC CAM FOLLOWER
FLOW SENSING CAM
MAGNETIC POSITION CONVERTER
MAGNET (ENCLOSED IN FLOAT EXTENSION)
POINTER FOR DIRECT INDICATION OPERATES INDEPENDENTLY OF PNEUMATIC TRANSMITTER
NOZZLE BACK PRESSURE 0.6#-1.5#
REDUCED PRESSURE AIR, 6#
ZERO ADJUSTMENT
REMOVABLE RESTRICTION
SUPPLY AIR, 20#
OUTPUT AIR, 3-15#
NISPAN C - CAPSULE FOR CAM FOLLOWER
RANGE ADJUSTMENT

A flow sensing cam is at the top of the magnetic position converter. This cam is the calibration curve of the rotameter plotted on polar coordinates and is characterized to meet any requirements. Alongside the converter is a pneumatic cam follower. In operation, as the metering float moves, the flow sensing cam is turned and the pneumatic cam follower automatically traces the leading edge of the cam and transmits an air signal corresponding to this position or to flow rate. Unit is unaffected by vibration and a wide range of temperature variations. Supply air pressure variations from 20 to 25 psi have no effect on output pressure.

Circle 427 on Page 131



Adjustable Speed Drive

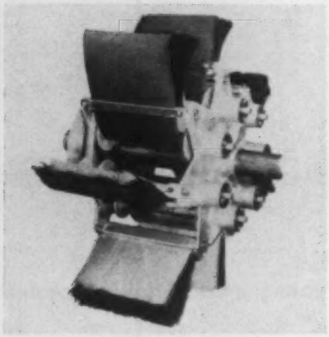
Item 428

Speed Variator is adaptable for use on continuous processing lines, machine tools, crane hoists, paper processing machinery, or on any operation where adjustable or fine control is required. It converts incoming ac power to dc power which it transmits to the dc drive motor. Unit is designed to have a minimum of maintenance. The control components in the power-unit are unit-mounted and front-connected for convenience in inspection and servicing.

The regulator, designated Amplistat, has silicon rectifiers which provide smooth, timed acceleration and deceleration to preset speeds. The motor-generator set is a two-unit, four-bearing design. Connection is by a flexible coupling. Terminal boards for incoming power leads are mounted on the motor and the generator. The set can be lifted out by fork truck for inspection and servicing.

The case ends are free of any devices or openings, so the units can be balcony mounted, placed end-to-end, end-to-wall, or back-to-wall with only a small air space for ventilation. Speed ranges from 8 to 1 to 200 to 1 are available, with horsepower ratings from 3 through 150. **General Electric Co.**, Schenectady 5, N. Y.

Circle 428 on Page 131

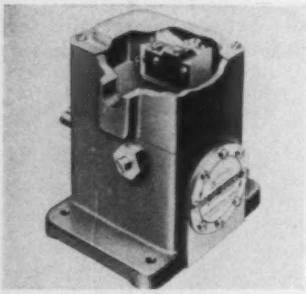


Coated Abrasive Head

Item 429

Unit carries a supply of abrasive for replenishing worn material. It is particularly adaptable to aluminum finishing in the preparation of extruded shapes for anodizing, or in any automatic operation where both contours and flat surfaces require scratch finishes ranging from satin to coarse finishes. The material is fed from rolls which are automatically advanced by manual or solenoid activation. The head is designed to use either cloth or paper backed silica carbide or aluminum oxide abrasive. Unit is available in widths from 2 to 50 inches. **Abrasive Machinery Corp.**, Dept. H-471, 444 S. Pennsylvania St., Indianapolis 25, Ind.

Circle 429 on Page 131

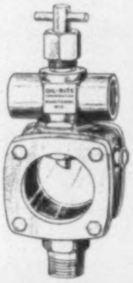


Motion Indicator

Item 430

Device is applicable on conveyors, elevators, feeders, or on any operation where positive indication of motion or lack of motion is required. Unit, designated Roto-Guard, converts rotary motion into a signal. The rotating shaft drives an impeller pump which pushes fluid against a diaphragm and raises a spring-loaded plunger that closes an electric circuit. When the unit stops, no pressure is being delivered at the diaphragm and the spring causes the plunger to retract, breaking the electric circuit. This change actuates the control switches and shuts down the operation. This signal impulse can be used to energize an alarm system, or to operate control switches automatically. The indicator is connected to any slow turning shaft which is operating normally. If the rotation of the driven shaft goes below operating level or stops, the drop in pressure sets off the alarm signal. When used to operate control switches, the device can be wired to an interlock system. Indicator is designed to operate at speeds of 10 to 150 rpm, is adjustable within that range. **Bin-Dicator Co.**, 13946-209 Kercheval Ave., Detroit 15, Mich.

Circle 430 on Page 131



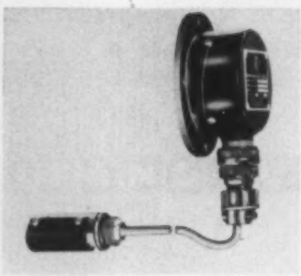
Sight Feed Valve

Item 431

Indicator features a large sight with double windows, for visual observation of a liquid stream from either side. It is applicable to paper mill machinery, rolling mills, and gear units, or on any operation requiring adjustable, visible flow control of oiling systems. The valve can be regulated from full flow to complete shutoff. The volume of flow discharge is controlled by a needle valve.

The windows can be rotated to a viewing position which is most suitable for the application. It is done by removing the sight glass and loosening the inside lock nut of the needle valve. A vent screw prevents clouding of the glass. The windows can be removed for cleaning without disconnecting the valve. Unit is available in four sizes, from ¼-inch to ¾-inch pipe thread. **Oil-Rite Corp.**, 2312 Waldo Blvd., Manitowoc, Wis.

Circle 431 on Page 131

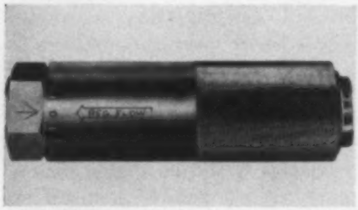


Liquid Level Control

Item 432

Indicator is designed for use with water-alcohol mixtures, jet and hydrocarbon fuels, hydraulic and lube oils; can also be used in any other fluid that is compatible with the stainless steel probe housing. In applying power to indicator lamps, pumps, and valves, unit incorporates a photoelectric level sensing probe and operates on the principle of total internal reflection. Repeatability is within 0.015 inch, with operation in milliseconds. Probe temperature range is −65 F to +250 F. Unit contains no moving parts and can handle up to 10 amp. **Revere Corp. of America**, Wallingford, Conn.

Circle 432 on Page 131



Flow Regulator

Item 433

Device is suitable for use on operations where the exact flow rate cannot be determined or where frequent flow change is required. Changes in flow rate are accomplished by rotation of the valve sleeve. In the closed position a beveled shoulder on the sleeve contacts an annular shoulder on the body. Rotation of the sleeve results in the beveled shoulder moving away from the annular shoulder on the body increasing the orifice area which increases the flow rate. Free reverse flow is provided for by a built-in check valve. Under conditions of extreme vibration, a socket setscrew is included for positive locking. Valve is available in ¼,

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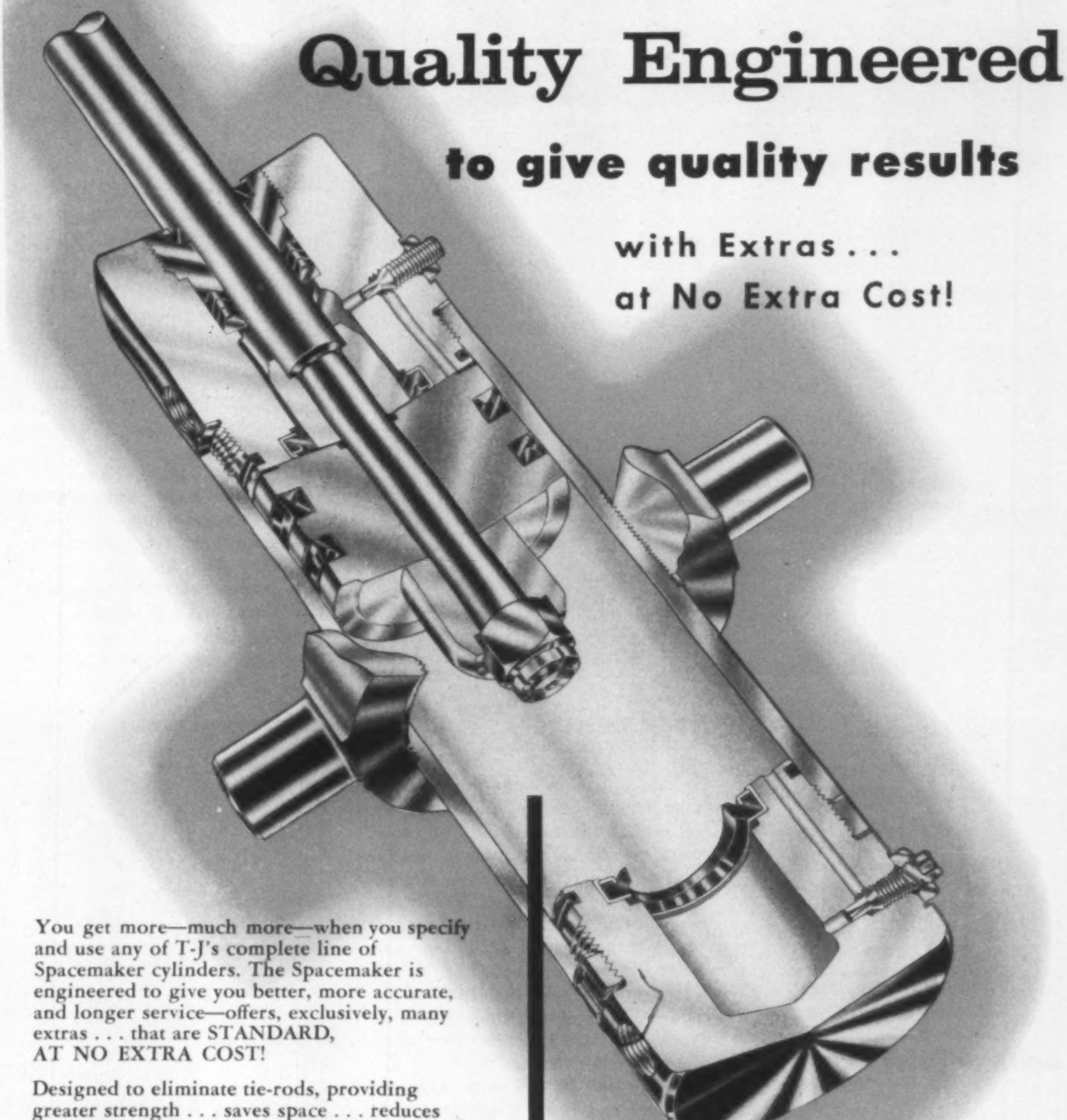
with Extras . . .
at No Extra Cost!



You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

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METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

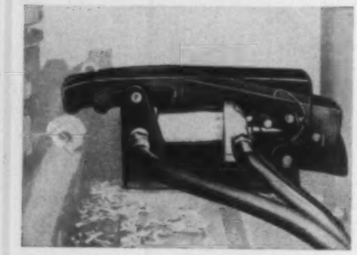
STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

Circle 685 on Page 131

$\frac{3}{8}$, and $\frac{1}{2}$-inch pipe sizes for flow rates to 5, 10, and 18 gpm. Maximum operating pressure is 3000 psi. **Fluid Power Accessories Inc.**, P. O. Box 64, Glenview, Ill.

Circle 433 on Page 131

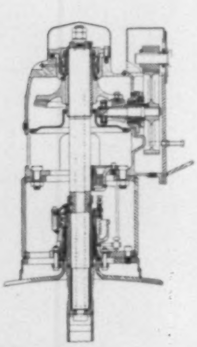


Pneumatic Clamp

Item 434

Automatic, air-operated, heavy-duty clamp is cam-locked to hold the clamp locked if air failure occurs. Unit is said to deliver ten times the line pressure. It is made compact by locating the air cylinder under the clamp. Dimensions of the unit are: 3 inches wide, $3\frac{5}{8}$ inches high, and $8\frac{1}{4}$ inches long. **Lodding Inc.**, Worcester, Mass.

Circle 434 on Page 131



Agitator Drive

Item 435

Unit is designed for use on 300 gallon through 4000 gallon agitated vessels. Features of the drive include pilot fit, interchangeable seal or stuffing box, wide bearing span, hardened and lapped spiral bevel gears, five leakproof oil seals, and a T-head drawbar design. Device allows more nozzle openings because of the use of a fitted pedestal mount in place of tripod legs. The drive shaft uses only two bearings which increases agitator stem length and reduces vibration.

Design of the T-head drawbar provides tapered rings to transmit torque when the bar is drawn. To replace a seal or stuffing box unit, the drawbar disengages the drive shaft from the agitator and the shaft is withdrawn through the top of the drive to allow the sealing unit to be slipped out. The replacement seal or stuffing box, with the self-contained drive shaft sleeve, is inserted, the shaft repositioned, and the drawbar taken up to connect the agitator. Drive is rated at 12, 30, and 60 hp at 100 rpm. **Pfaudler Co.**, 1065 West Ave., Rochester, N. Y.

Circle 435 on Page 131

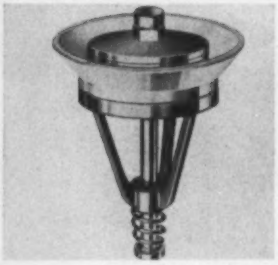
Fog Lubricator

Item 436

Device delivers a controlled amount of airborne lubrication to all bearings, gears, chains, and cams on a machine. Lubricator is totally enclosed in a splash-proof cabinet which can be key locked. It is available in one or two quart oil capacity, with a choice of 32, 200, or 300 rated bearing inch capacities. An air filter automatically removes liquids and solids from the air supply and drains collected moisture. The pressure regulator reduces main line air pressure to the required working pressure and holds it constant.

The lubrication process starts and stops by means of a solenoid valve which is actuated as the machine power is turned on and off. If air pressure fails, a pressure switch actuates an alarm and shuts down the machine. Optional equipment available is a liquid level control which will stop the machine when the oil supply needs replenishing. **C. A. Norgren Co.**, Englewood, Colo.

Circle 436 on Page 131

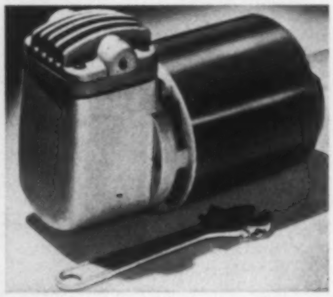


Check Valve

Item 437

Device is designed to prevent line flow of liquid in one direction while allowing free flow in the opposite direction. The valve can be easily installed in existing piping by loosening the union locking ring and separating the union. The check valve is inserted so that the face of the union rests against the gasket type fins. The union locking ring is tightened and installation is complete. Valve body is molded of 101 grade nylon which provides a fine surface finish for separate seating of the disc and low pressure drop. **Jordan Industrial Sales, Div., OPW Corp.**, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle 437 on Page 131



Diaphragm Pump

Item 438

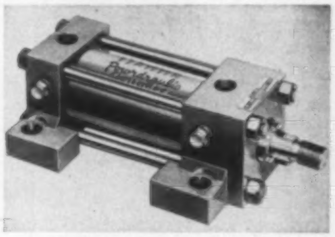
Low-volume diaphragm pump delivers oil-free air. Unit provides continuous operation, vacuum up to 22 inches hg, pressure up to 40 psi, and a maximum displacement of one cfm at free flow. The Neoprene nylon valve gasket and diaphragm prevent rusting and jamming. Pump has a GE motor, is rated for 115v, 60 cycle. A 220v, 60 or 50 cycle motor can also be furnished. **Air-Shields Inc.**, Hatboro, Pa.

Circle 438 on Page 131

Hydraulic Cylinder

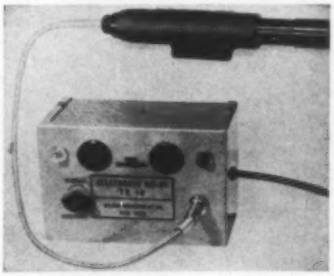
Item 439

Line of high pressure hydraulic cylinders is available in $1\frac{1}{2}$-inch through 8-inch bore sizes, rated at 2000 psi and 3000 psi nonshock hydraulic pressures. A feature of the cylinder is the method for sealing the head to the tube. The seal is located on the outside diameter of the tube and is fully confined between the head and tube. Minor expansion of the tube due to hydraulic pressure squeezes the O ring seal and makes the seal tighter. It will remain tight under all pressures.



Other features include a choice of standard Vee or cartridge type rod packings and a choice of metal piston rings or cup type piston packings. The cylinder is available in 13 different mounting styles, with a choice of rod sizes for each bore. **Hanna Engineering Works,** 1765 Elston Ave., Chicago 22, Ill.

Circle 439 on Page 131



Temperature Control

Item 440

Device is adaptable to induction heaters, crucibles, gas flame or torch, or furnaces. Controller is sensitive only to the temperature level of the work. Known as Pyrotel, it can detect and react to moving heated objects, can be used for counting or initiating a process when the work passes a given point. Unit can sense the heat level from very small objects, or it can signal or control a

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For general use or for specific applications demanding the most exacting requrements, the Baltric line of motors more than fills the bill. One reason is the "Monocast" Stator shown above.

Steel laminations in an aluminum alloy casting form a stator frame of greater stability . . . greater rigidity. This permits the use of a new and better slot design. The result is uniform magnetic flux distribution throughout the motor—gives more power, greater efficiency, higher power factor and quieter operation.

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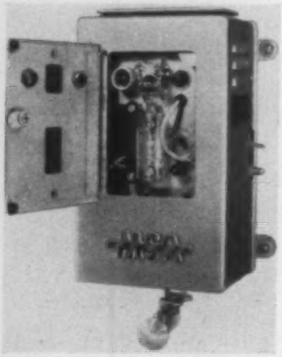
Circle 686 on Page 131

set point in a foundry crucible.

An optical system points at the work, focuses the infra-red radiation which it sends to a photocell. The output signal of the photocell is electronically amplified and triggers an electronic relay which can sound an alarm or shut off heater controls. Operating range is 950 F to 2000 F. Repeat accuracy is within 1 per cent of scale. **Mason Instrument Co.,** 29 Elm Ave., Mt. Vernon, N. Y.

Circle 440 on Page 131



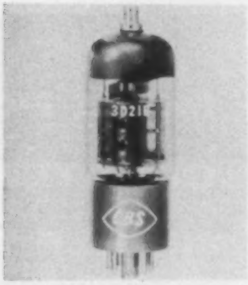
Combustible Gas Alarm

Item 441

Unit is adaptable in industrial plants where combustible gas is used, in pump rooms for flammable products, or on gas-fired industrial ovens to check the atmosphere before igniting burners. The control cabinet is designed for installation in nonhazardous areas. To convey the sample stream out of the potentially-explosive area to the instrument, a sample line as long as 50 feet can be used. The motor-driven pump pulls a sample-volume flow of 4½ liters per minute.

In operation, an integral diaphragm vacuum pump draws a sample stream across a heated filament that is one resistance arm of a wheatstone bridge circuit. Any combustible gases present burn catalytically at the hot filament surface, raising its temperature and its resistance. This resistance change unbalances the electrical bridge causing an output voltage proportional to the concentration of combustible gases. The output signal then actuates an alarm light or horn. **Mine Safety Appliance Co.,** 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle 441 on Page 131

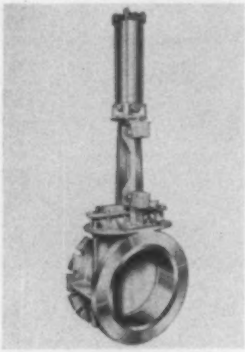


Pulse Modulator

Item 442

Pulse modulator, a beam power tube, can also be used as a high-voltage blocking oscillator, hard switch tube, deflection amplifier, and regulator or pass tube in high-voltage supplies. It is capable of delivering 21 kw in 10 microsecond pulses. Model USN-3D21B features an open-type plate of large area for high thermal dissipation, a nonwarping cathode, and goldplated alloy grids with heavy side rods and oversize heat radiators. Tube is rated to withstand a plate pulse voltage of 5 kv. **CBS-Hytron,** Parker St., Newburyport, Mass.

Circle 442 on Page 131



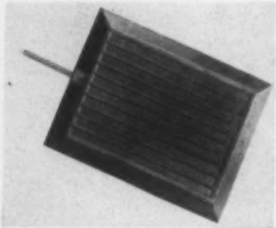
Capping Valve

Item 443

Especially suitable in the pulp and paper mill industry, stainless steel capping valve is also applicable for the chemical processing and petroleum industries. When the standard bolt-on cap is used, it is necessary to wait several minutes after a cook to unbolt the cap, then rebolt after the digester is loaded. With the capping valve, the same operation is completed in seconds.

The digester valve gate is operated from the digester control panel. All the digesters in a mill can be linked together with valve gates controlled from a central panel for a completely automatic cooking operation. To guarantee against premature opening of the valve, a pressure switch is available to prevent operation above 3 psi. **W. G. Rovang & Associates,** Dept. A 35, 1945 N. Columbia Blvd., Portland 17, Ore.

Circle 443 on Page 131

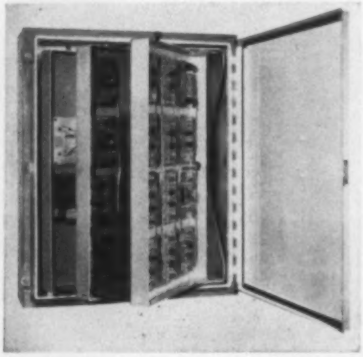


Electrical Foot Switch

Item 444

Waterproof construction makes switch suitable for machine shops, chemical plants, and food processing industry. Switch can be actuated by foot or toe, will respond under the most severe environmental conditions. Electrodes are embedded in a flexible plastic which is resistant to water, oil, grease, and other common chemicals. **Recora Co. Inc.,** 6100 S. Archer Rd., Summit, Ill.

Circle 444 on Page 131



Telemetering Transceiver

Item 445

Unit transmits and receives digital information over telephone lines, radio, or micro-wave links, is applicable in data handling, computing, printing, or supervisory control systems. Model TTR uses two-frequency, switched-tone modulation; one frequency represents binary

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Eriez, leader in design and research of magnetic equipment, introduced most of the types of permanent, non-electric magnetic units on the market today. Specifically, we build standard lines of magnetic separation equipment and in addition, design and build special Magnamation components to magnetically convey, transfer, control, elevate, re-position, hold or re-orient basic ferrous materials or finished parts.

Our laboratory and field staffs, backed by the know-how and versatility of solving countless magnetic problems of all types, are among the most skilled in this line. They are continually developing and perfecting new models to meet the ever-changing needs of industry. By studying your particular problem, they will recommend the *lowest cost* magnet in *proper size and strength* to do the job best.

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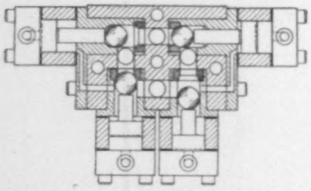
Zero bits, the second represents binary *One* bits. Each digit consists of five binary bits.

The encoded information is sent serially by digit in modified binary coded decimal form. Information can be sent at speeds up to 10 decimal digits per second. All frequencies used are within the bandwidth of commercial-grade telephone lines. Transmission is independent of time and tone lengths, can be adjusted to compensate for noisy transmission facilities. Transceiver automatically rejects erroneous signals and sends acknowledgements when the message has been correctly received. **Southwestern Industrial Electronics Co.,** 2831 S. Post Oak Rd., Houston, Tex.

Circle 445 on Page 131



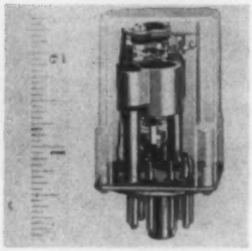
Four Way Ball Valve

Item 446

Unit is designed for any hydraulic fluid regardless of viscosity or lubrication qualities. Valve incorporates four hardened steel balls. Each ball is pressed against an individual hardened steel seat for closing the fluid passage that it controls. The balls are pressed against their seats by the action of integral hydraulic cylinders. When pilot pressure is applied to a cylinder, the ball seals the passage—when the pilot pressure is removed, the internal pressure against the ball will move the ball out of the way for fluid flow. If shock pressure behind any ball exceeds twice the line pressure, the ball will be unseated and permit the fluid to escape to drain.

Unit can be used as a two-position or a three-position valve. As a three-position valve it has a center position where all balls are seated and all passages blocked. As a two-position valve it shifts through the center position without hesitation. **Almar Hydraulic Valve Co.,** 10011 Meech Ave., Cleveland 5, Ohio.

Circle 446 on Page 131



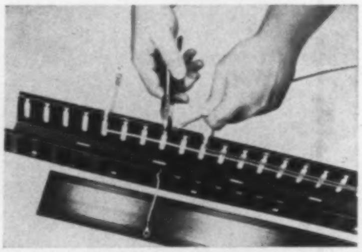
Meter-Relay

Item 447

Model 137 features unit enclosed in a plastic case for visual observation of operation. A moving coil armature rotates in the flux gap of a magnet. The movement rides on polished pivots in vee cup jewels. The pointer on the movement is a contact of solid Iridium Platinum. A contact locking coil develops high contact pressure and provides steady operation even under vibration.

Contact arrangement can be *High* limit, *Low limit,* or both *High* and *Low* limits. The zero point can be between the two limits or above or below them. Contact locking coil is rated 5-25 dc ma. Open circuit contact voltage is 75-125. Trip points range from 0.2 microampere to 10 amp for current sensitive units and from 0.1 mv to 500 v. Accuracy of the trip point is within 3 per cent. **San Gorcinto Div., Assembly Products Inc.,** P. O. Box XX, Palm Springs, Calif.

Circle 447 on Page 131

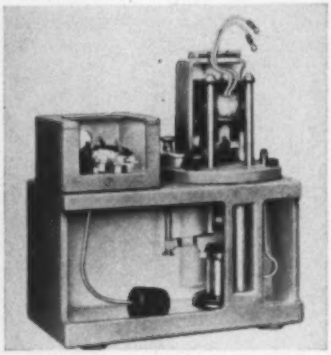


Web-Slot Raceway

Item 448

Channel is designed to give added sidewall rigidity on longer wiring runs. A narrow strip of material spans the open throat of each slot. The strip or web is snipped out when the wire is inserted through the throat of the slot. Unused slots are not cut, and provide the additional rigidity to the channel. When the web is cut, the wires can be conveniently slipped in and out of the slot, but the narrow throat prevents the wire from accidentally sliding out. The raceway, made of lightweight phenolic which does not warp under high temperatures, is available in a variety of sizes and styles with either vertical or diagonal slots. **Stahlin Brothers Inc.,** 442 Maple St., Belding, Mich.

Circle 448 on Page 131



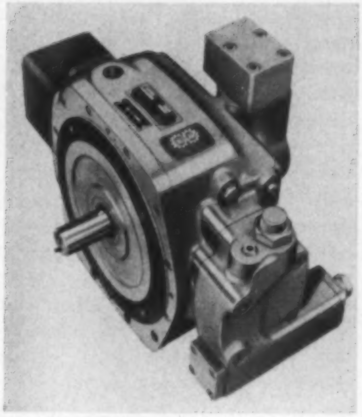
Automatic Lubricator

Item 449

Device actuated by a solenoid can lubricate as many as 20 average bearings. A three-pint or a six-pint reservoir can be used. With the larger reservoir, a choice of different automatic warning systems is provided. One is operated by a single-contact float switch which sets off a visible or audible alarm when the oil supply is low. The second is operated by a double-contact switch. It gives the alarm, and if oil is not added in a short time, it automatically shuts down the machine.

In operation, oil is drawn into the unit through a filter and check valve as the solenoid raises a piston against spring pressure. Interruption of current releases the piston and forces the oil through another check valve and out into the distribution system to the bearings on the machine. Measured quantities of oil are discharged through company meter-units. The volume of oil delivered is determined by the piston stroke setting. Range varies from 0.2 cc to 0.8 cc per cycle. Control of the solenoid from a machine's cycle or a timer provides automatic lubrication. **Bijur Lubricating Corp.,** 151 W. Passaic St., Rochelle Park, N. J.

Circle 449 on Page 131



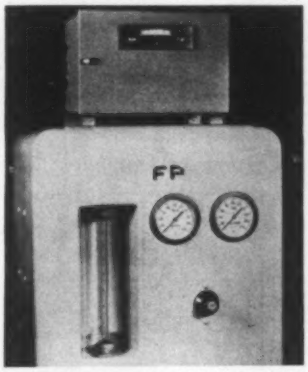
Hydraulic Pump

Item 450

Hydraulic pressure unloading pump is designed so that when the adjustable preset pressure is reached on applied work, the control hydraulically reduces the pump volume to slip stroke, saving input power, reducing heat, and holding the pressure. Model ANP features a balanced flat valve for controlled oil film between working surfaces, a separate wear plate, integral adjustable volumes and pressure unloading control, and a bearing type slideblock.

Pump is available for clockwise or counterclockwise rotation. It is built for face (shown), right angle bracket, or adapter mounting. Working pressure range is from 200 to 1100 psi, maximum delivery 3100 cipm. **Oilgear Co.**, 1571A W. Pierce St., Milwaukee 4, Wis.

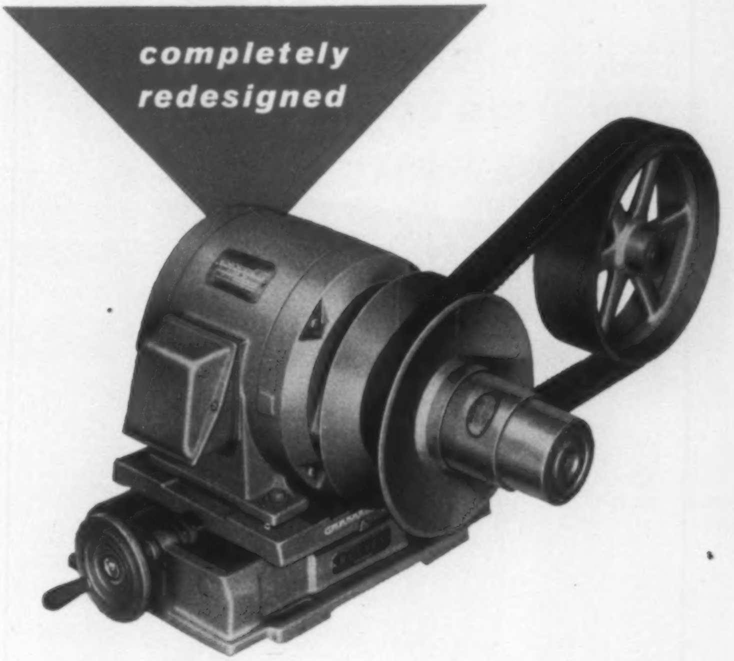
Circle 450 on Page 131



Pneumatic Chlorinator

Item 451

Device automatically proportions chlorine flow to primary flow; it can

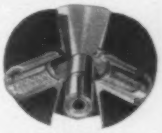


REEVES® *Vari-Speed MOTOR PULLEY*

Here is variable speed control in its most simplified form . . . variable speed control with new economy.

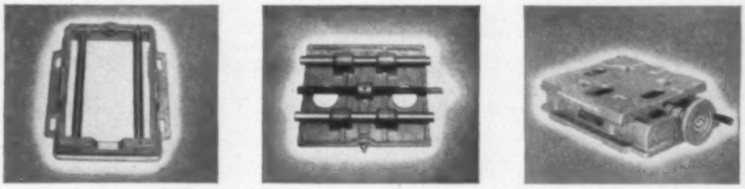
Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit both old and new NEMA motors.

Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin AN366-V582



Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.



Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

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Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.®

Columbus, Indiana

Circle 688 on Page 131

Smooth, quiet
power transmission
for heavy loads—

H & S Herringbone
Speed Reducers
HORSBURGH & SCOTT

The Herringbone gear design provides continuous tooth action — eliminates end thrust.

Built for heavy load conditions, Horsburgh & Scott Herringbone Speed Reducers give you dependable economical service. They're available in single, double and triple reduction units. Check these 9 points of superiority:

1. Overall design conforms to AGMA specifications.
2. All bearing loads are balanced, due to the symmetrical design of the gearing.
3. Oversize bearings and low speed shaft provide tremendous overhung load capacity.
4. Heavy wall and base-pad thickness provides extra housing rigidity.
5. Housing designed with box-type construction for maximum thermal capacity.
6. Every gear is accurately sized and then cut on a modern Sykes continuous tooth gear generator.
7. All pinions are integral with the shafts and are made of heat treated alloy forgings.
8. Dust and oil-proof seals are provided on shafts extending outside the housing.
9. Splash lubrication floods all bearings and gears.

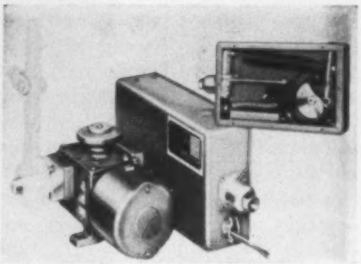
You'll find a wealth of information in our Catalog 55 describing our complete line of Speed Reducers. Write for it, or ask your nearby H & S representative.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue
Cleveland 14, Ohio

Circle 689 on Page 131

also be used as the final control element in a residual chlorine control setup. Model 70C1415 uses a ratio relay assembly which serves as a dosage adjustment. It receives a 3-15 psig linear signal from the flow transmitter and transmits another 3-15 psig signal to the chlorinator's pneumatic rate valve. The output signal from the ratio relay unit is maintained at an adjustable preset ratio to the input signal. When used as a control element, the chlorinator's pneumatic rate valve is operated by a 3-15 psig signal transmitted directly from a residual chlorine analyzer. **Fischer & Porter Co.**, 693 Jacksonville Rd., Hatboro, Pa.

Circle 451 on Page 131



Temperature Control

Item 452

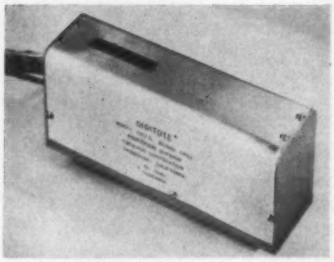
Regulator features a drive motor which can be stalled indefinitely and continuously reversed. It can control gas or liquid pressure, or gas or liquid temperature in a process system. Unit is electrically operated, has a highly sensitive mechanism, with wide proportional band adjustment range. Regulator shown has a torque range up to 204 in.-lb and a pressure range up to 600 psi. Other units are available with up to 12,000 in.-lb torque. A handwheel with clutch is included for hand control. **Optimum Control Corp.**, 2930 Woodhill Rd., Cleveland 4, Ohio.

Circle 452 on Page 131

Totalizer/Readout

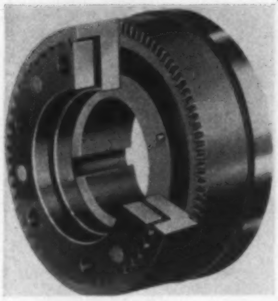
Item 453

Adaptable for both visual and electrical readouts, Model 7106 accepts pulses at a rate of 60 per second and totalizes any input quantity for remote indication, control, or telemetry. Five digit unit has a



totalizing capacity up to 99999. Number wheels are lighted for visual clarity. Unit, which can be used as a *Go/No-Go* indicator, a controller, or a digital recording output device, is available for vertical or horizontal mounting on equipment panels. **Digitran Co.**, 45 W. Union St., Pasadena, Calif.

Circle 453 on Page 131

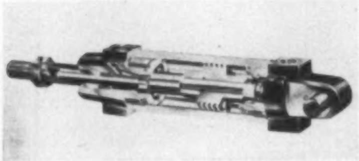


Tooth Clutch

Item 454

Electromagnetic tooth clutch utilizes the form locking principle to transmit torque. Engagement can be made up to 300 rpm relative speed, and disengagement under full load while running at maximum rpm. Clutch is said to have high torque transmission with reference to overall dimensions. It is available with torque ratings from 40 to 4000 ft-lb. **McCauley Industrial Corp.**, 1840 Howell Ave., Dayton 17, Ohio.

Circle 454 on Page 131



High Pressure Cylinder

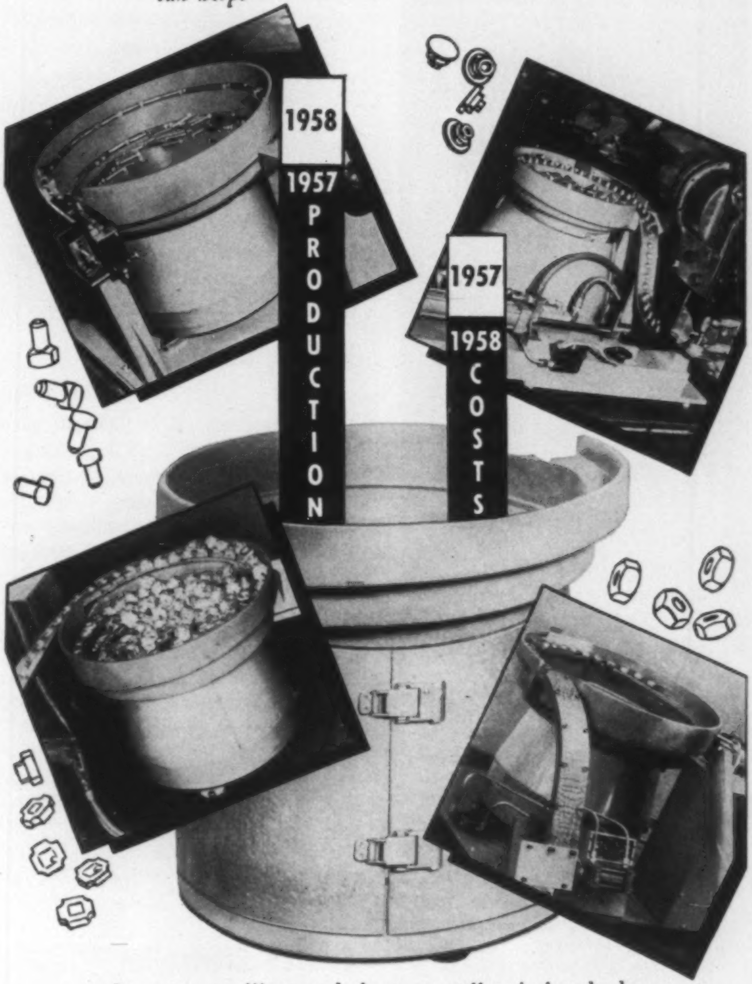
Item 455

Hydraulic units have operating pressures of 1000, 2000, and 3000

the shortest route to MORE PROFIT

. . . produce MORE in 1958!

If you can reduce costs while producing more, the job is twice as easy. This is where PEECO can help.



In every case illustrated above, as well as in hundreds of other examples, PEECO successfully helps production men reduce their costs by producing more—automatically.

If your equipment, machinery, production or assembly line is *not* now using parts feeders the chances are your costs are too high. Let a PEECO Sales Engineer give you the facts. He'll gladly help you without obligation. Write for literature and name of representative near you.

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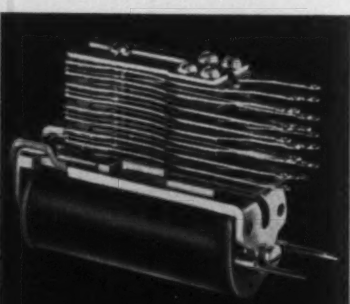
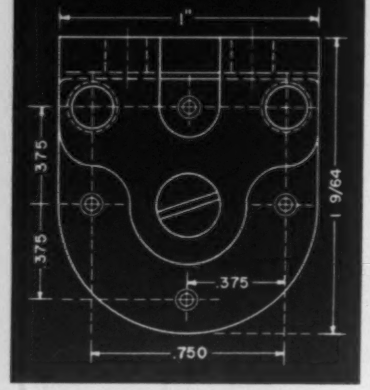
Circle 690 on Page 131



New "E" Relay

interchangeable with many other makes



Stromberg-Carlson's new type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the sketch above shows, our new frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeably with brands you have been using. Costs are competitive and expanded production means *prompt delivery*.

Welcome engineering features of the new "E" relay are—

★ **Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

★ **Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

★ **Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R.

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
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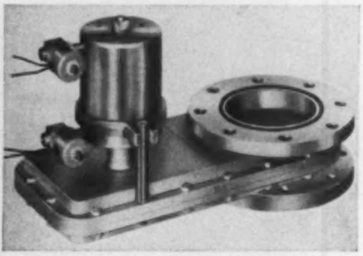
111 CARLSON ROAD, ROCHESTER 3, N. Y.

Circle 691 on Page 131

psi. The hydraulic cylinders can be cushioned or noncushioned. They feature forged steel heads, self-aligning adjustable cushions, a high pressure piston ring construction with three types of oversized ports, and extra long rod guide bearing design, all as standard equipment. **Tomkins-Johnson Co.,** Jackson, Mich.

Circle 455 on Page 131



Rotary Actuator

Item 456

Designed for high vacuum gate valves, device produces high-torque rotary motion. Linear movement of a guided plunger along a spirally fluted shaft in a pneumatically operated cylinder effects 180 degrees of shaft rotation. A feature of the control is that it can open or close the valve in a fraction of a second. Unit will operate at normal air pressures, or at pressures down to 50 psi. The cylinder can be remotely actuated by means of manually operated air valves. In case of power failure, the control can be wired for automatic instant closing or opening. **Vacuum Research Co.,** 420 Market St., San Francisco 11, Calif.

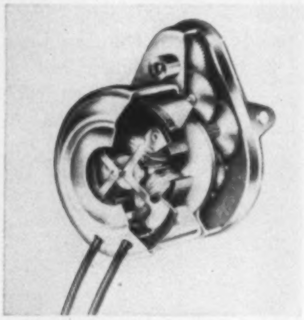
Circle 456 on Page 131

Switch Controller

Item 457

Unit is designed to allow exposed contact switching in atmospheres such as acetylene, hydrogen, ethyl ether, gasoline, naphtha, acetone, methyl ethyl ketone, metal dusts, combustible fibers, and other flammable fluids or gases. Controller is mounted in a nonhazardous area and can be used with any general purpose switch having exposed contacts which is to operate safely in hazardous locations. Unit is designed so that the maximum electrical spark energy available at the remote exposed switch contacts is less than the minimum required to ignite the surrounding hazardous atmosphere. Switching control distances up to 1000 ft are possible. **Brookdale Engineering & Services Co.,** 6 Beacon St., Boston 8, Mass.

Circle 457 on Page 131

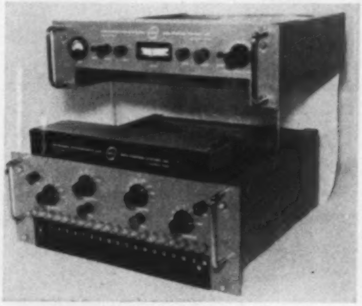


Miniature DC Motor

Item 458

Device features high-torque and low-current drain. Output speeds range from 900 rpm to 2 rpd with gear train, and from 960 to 3000 rpm without gear train, providing maximum torques of 30 oz-in. and 0.6 oz-in. Current drain can be as low as 30 ma. Model 800 is rated for 3 to 30 v dc. **Cramer Controls Corp.,** Centerbrook, Conn.

Circle 458 on Page 131



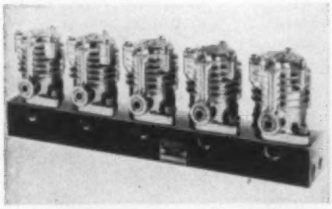
Discriminator

Item 459

Model GMD-1, a 20-channel ground-based subcarrier discriminator assembly is designed for use in FM/FM telemetry data systems.

Separate pushbuttons actuate a solenoid-operated 20-position rotary switch which selects all bandpass and output filter components to tune the discriminator to a standard IRIG telemetry channel. A front panel selector switch provides multiple receiver use. Selector switches permit monitoring of either input or output signals and feed output connectors for driving a counter, voltmeter, penmotor, or galvanometer. **Data-Control Systems Inc.**, 39 Rose St., Danbury, Conn.

Circle 459 on Page 131



Multiple Station Manifold

Item 460

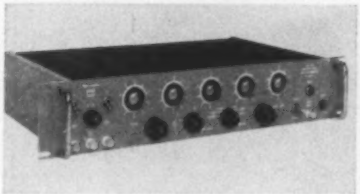
Device is suitable for mounting company's solenoid pilot valves. Manifold provides centralized valve panel installations; is available in 2, 3, 4, and 5-station types. They are designed to hold three-way normally open or three-way normally closed pilot valves in unmixed groups. A centralized filtering and lubricating air supply can be used with the manifold. Common inlet, exhaust and individual cylinder ports are tapped ¼-inch. **Valvair Corp.**, 454 Morgan Ave., Akron 11, Ohio.

Circle 460 on Page 131

Counter-Timer

Item 461

Instrument is suitable for use in telemetry, filter test and calibration, vibration analysis, flow measurement, transducer calibration, and time parameter measurement of relays, valves, and solenoids. The five-decade electronic counter has a response from 1 cps to beyond 100 kc. It measures frequency, period, time, interval, and a ten-period average. Standard frequencies of 100 kc, 10 kc, 1 kc, 100 pps, 10 pps, 1 pps, and 0.1 pps provide a maximum time resolution of 10 microseconds and maximum gate interval of 10 seconds.



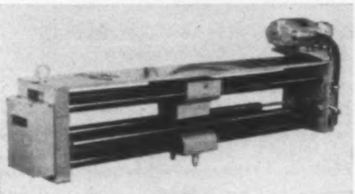
Features of Model 400 include a 25 mv sensitivity on frequency and period, continuously variable or infinite display time, three fully regulated power supplies, and slope selector for positive or negative-going input waveforms. **Erie Resistor Corp.**, 644 W. 12th St., Erie, Pa.

Circle 461 on Page 131

Thickness Gage

Item 462

Compact unit measures sheet materials in process and detects variations in sheet thickness. In operation, radiation from a source isotope housed in the unit passes through the process sheet and is collected in an ionization chamber located in the detector. Variations in sheet thickness produce a differential in the quantity of energy reaching the chamber, and an ionizing current induced in the chamber varies accordingly. The resulting voltages can be fed into a series of components which provide analog or digital analysis of the process, and actuate automatic control of the process to predetermined target specifications. **Industrial Nucleonics Corp.**, 1205 Chesapeake Ave., Columbus 12, Ohio.



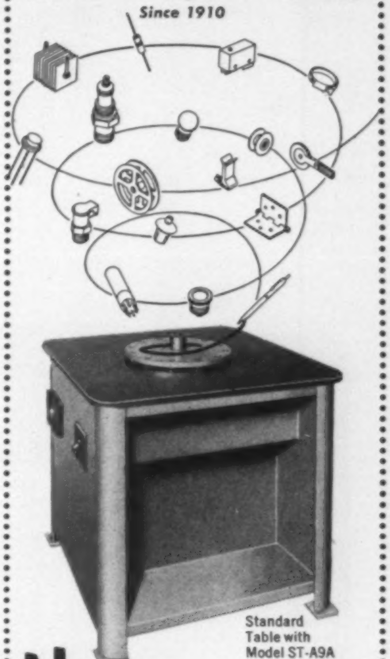
Circle 462 on Page 131

In-Line Filter

Item 463

Model M-2032-100 is suitable for in-line installation to handle hy-

STANDARD TOOL AUTOMATION
Since 1910

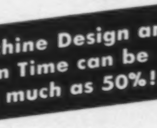

Standard Table with Model ST-A9A Basic Drive Unit

New-
STANDARD TOOL
MODEL ST-A9A
Cam-Operated Indexing Unit

1. Higher Torque Rating
2. Greater Versatility
3. Can be furnished with dial plates, tooling plates and tables with standard and special drives

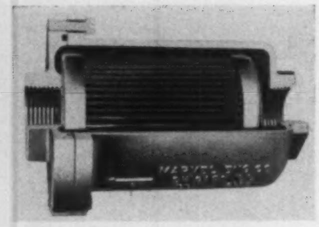
Automatic Machine Design and Construction Time can be Reduced as much as 50%!

Send for illustrated literature describing Standard Tool Indexing Units—the basic units for Automation

Basic Cam Operated Indexing Unit MODEL ST-A9A


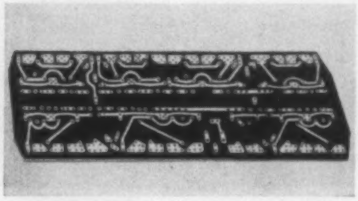
STANDARD TOOL AND MANUFACTURING CO.
Creative Machine Designers and Builders
245 LAUREL AVENUE
KEARNY, NEW JERSEY

Circle 692 on Page 131



draulic oil from 10 to 25 gpm capacities at low pressure drop. Filtering media is Monel wire cloth, is available in mesh sizes from 30 to 100. Cartridge is removable for easy cleaning. Over-all length is $6\frac{1}{8}$ inches, head diameter $4\frac{1}{4}$ inches, case diameter $3\frac{1}{8}$ inches, openings are 1-inch NPTF at both ends. **Marvel Engineering Co.,** 7227 N. Hamlin Ave., Chicago 45, Ill.

Circle 463 on Page 131

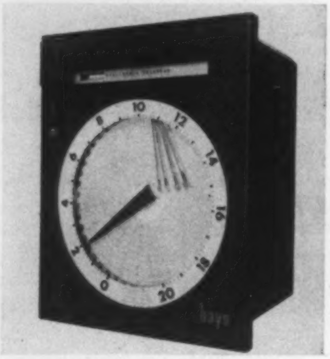


Epoxy Glass Base

Item 464

Suitable in applications requiring mechanical strength at elevated temperatures, device is constructed to retain 70 to 80 per cent of its original flexural strength when tested at 150C after conditioning for one hour at that temperature. Epoxy laminates are also made as copper clad phenolite for printed circuit applications. Bond strength is 10-15 lb, dip solder resistance greater than 30 seconds at 500 F. **National Vulcanized Fibre Co.,** Box 311, Wilmington, Del.

Circle 464 on Page 131



Electronic Recorder

Item 465

Circular chart recorder can handle inputs such as flow, gas analysis, and pH pressure on a single equally divided chart. Applications for the recorder are limited only by the incoming signal or by a transmitter available for a particular measurement. Unit shown has four pens plus an integrator. Components in the recorder include a slidewire receiver with calibration box, differential transformer receiver, mechanical integrator, and amplifier. The chart plate features hooded illumination, calibration box adjustment, transparent pointer support, and integrator or pneumatic loading signal readout. A cam is used in all electronic receiver units to correct non-linearity of input signals.

Two types of receivers are available. One is a differential transformer type which is used with

Now! THE ALL-NEW
DPS
MODEL U (Universal)
POWER SCREWDRIVER

WITH BRAND NEW FEATURES AND ADVANTAGES NEVER BEFORE AVAILABLE

NEW TYPE POSITIVE CONTROL CLUTCH

- Not affected by changes in temperature or excessive oil or grease
- Sharply increased accuracy as to variation in torque tolerance
- Simplified design for easy servicing
- Requires no daily lubrication
- No friction devices of any kind used
- Long service life on all parts subject to wear

NEW TYPE HOPPER DRIVING MECHANISM

- No gears to wear out
- No lubrication required
- No costly replacement parts
- Simple design for easy servicing
- Built-in slip control as a safety feature

Also furnished as a completely Self-Contained Driving Head for use in specially designed assembly machines.

NEW TYPE FEED TRACK AND ESCAPEMENT MECHANISM

- Flexibility for easy and fast adjustment
- Escapement does not require daily lubrication
- Escapement design permits releasing screws by body or head as required
- Positive solenoid action
- Simple design for easy servicing
- Adjustable for full capacity of machine

Write for NEW Brochure!

DETROIT POWER SCREWDRIVER CO.

2811 W. FORT ST. DETROIT 16, MICH.

Circle 693 on Page 131

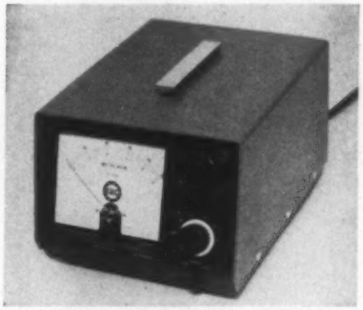
transmitters. These transmitters are used for pressure, temperature, flow, and liquid level. The second type is a slidewire receiver, with a cam, which is used in ac resistance bridge measurement as well as dc potentiometer type circuitry. For totalization of incoming signals, a maximum of two continuous mechanical integrators is available within a single recorder. Readout of the integrators is possible through the recorder door. One basic amplifier will operate both types of electronic receivers. **Hays Corp.**, Michigan City, Ind.

Circle 465 on Page 131

Moisture Monitor

Item 466

Instrument accurately measures minute quantities of moisture in gaseous mixtures. It can measure water content down to 10 ppm full-scale, and permit precise meter readings over the range of zero to 20,000 ppm, by means of a 6-position attenuator. The output of the analyzer can be telemetered to a remote recorder for monitoring or control. This extended range enables the instrument to follow changes in moisture content of chemical streams during upsets or off-specification periods. It also gives high-sensitivity measurement during normal operation.

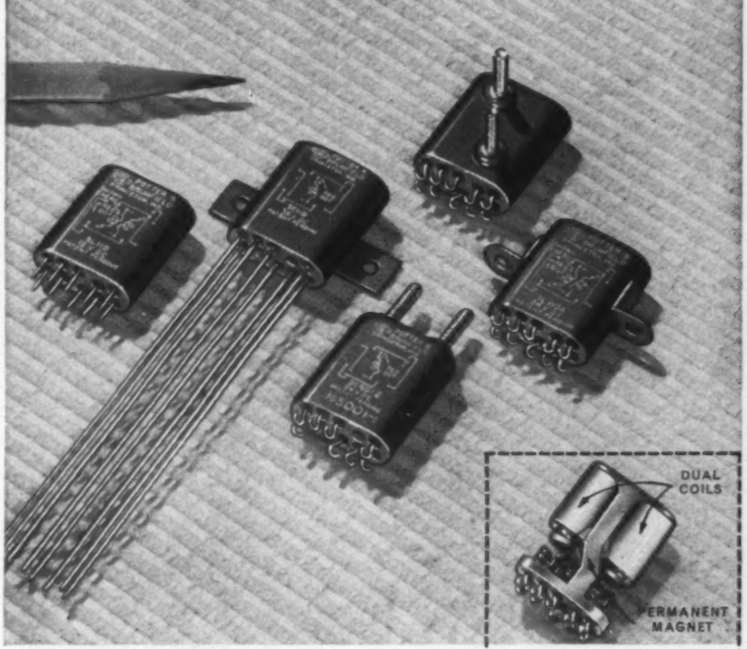


Operation of the instrument is based on a principle developed by E. I. du Pont de Nemours & Co., Inc. An electrolysis cell in the instrument continuously absorbs and electrolyzes all water present in a sample stream. A dc voltage is applied to the elements of the cell and the electrolysis current measured with a multirange meter. The electrolysis current is used as an in-

P&B MICRO-MINIATURE RELAYS LEAD IN

performance

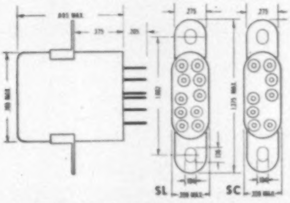
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:

Insulation Resistance: 10,000 megohms, min.

Breakdown Voltage: 1,000 V. RMS.

Shock: 100g

Temperature Range:—65° C. to +125° C.

Vibration: 30g 55 to 2000 cps.; 0.195" max. excursions from 10-55 cps.

Weight: 15 grams without mounting bracket.

Operate Time: 3 MS max. with 550 ohm coil @ 24 V. DC (SL: 630 ohm coil at 24 V. DC).

Transfer Time: 0.5 MS max.

Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.

Enclosure: Hermetically sealed.

CONTACTS:

Arrangement: 2 Form C.

Material: Gold flashed palladium.

Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V 60 cycles AC, resistive.

Pressure: SC—16 grams min.; SL—20 grams min.

COIL:

Power: Approx. 1.0 watt at Nominal Voltage.

Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.

Duty: Continuous.

MOUNTINGS:

Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

Circle 695 on Page 131

MOLINE

HD68 drills bolt circles from 12" to 100" diameter. Each of the two spindles has capacity for 2½" drill in steel. Operating cycle is fully automatic.

HD13 straight line-type drilling machine with capacity for thirty ¾" drills in steel. Used for work on heavy castings, round and rectangular steel tubes, structural shapes, plates and grader blade drilling or countersinking.

For Greater
PRODUCTION . . . EFFICIENCY . . . SAVINGS

Use an individually designed "Hole-Hog" Machine Tool for such jobs as...

- Multi-Spindle Boring
- Single and Multi-Spindle Honing
- Straight Line Multi-Drilling
- Adjustable Spindle Drilling
- Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
- Transfer-Type and Special Machines

OVER 57 YEARS OF MACHINE TOOL ENGINEERING EXPERIENCE IS AT YOUR SERVICE. TELL US YOUR PARTICULAR PROBLEM

13CB hydraulic feed cylinder boring machine. V-8 engine blocks are rough and finish bored for wet-type cylinder sleeves. Units of this kind are applicable for transfer machines.

MR152 performs drilling, reaming, spot facing and chamfering operations on tractor rear axle housings. A companion machine, MR151, does tapping in addition to the foregoing operations. Work holding fixtures are mounted on power driven trunnion.

MOLINE TOOL CO.
HOLE-HOG
MOLINE, ILLINOIS

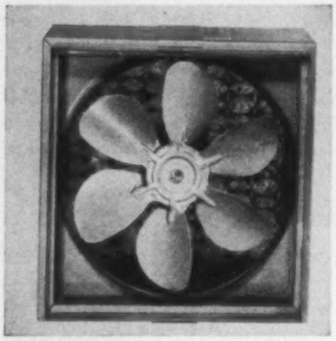
MOLINE TOOL COMPANY
REPRESENTATIVES IN PRINCIPAL CITIES
100 20TH STREET • MOLINE, ILLINOIS

109

Circle 696 on Page 131

dication of water content. A flow controller keeps constant the rate-of-flow of sample into the analyzer. Model 26-302 is rated for 105 to 125 v ac, 50/60 cycles. Where no electric power is available, unit can be operated with a battery pack. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 466 on Page 131

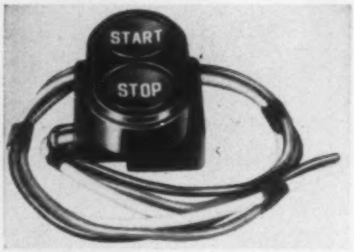


Cooling Fan

Item 467

Line of electronic cooling fans can be used to either suck or blow air. Unit is totally encased, has a built-in filter case, and can be mounted inside or outside a cabinet. The filter can be the permanent or disposable type. Fan orifice is recessed for maximum air delivery. Fan is available in three sizes, is rated at 115 v, 60 cycles, single phase. **McLean Engineering Laboratories**, P. O. Box 228, Princeton, N. J.

Circle 467 on Page 131

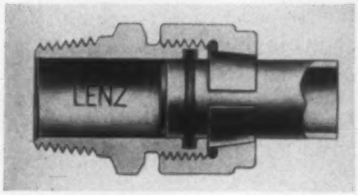


Starter Conversion Kit

Item 468

Material in kit can be used to install pushbutton or selector switch pilot controls on company's size 0, 1, and 1¾ magnetic starters. Kit contains pushbutton or selector switch unit with three color coded lead wires, one pair of spring clips for attaching a pushbutton; and an instruction sheet with wiring diagrams. **Furnas Electric Co.**, 1128 McKee St., Batavia, Ill.

Circle 468 on Page 131

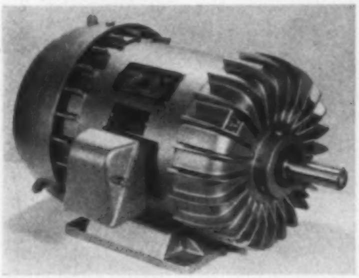


Tube Fitting

Item 469

Fitting can be used on vacuum, air, and hydraulic systems. Fitting seals by means of a standard stock O-ring; a split tapered sleeve holds the tubing in place when the clamping nut is drawn up. The higher the pressure, the greater the grip of the tubing and the seal of the O-ring. The unit can be disassembled and reassembled when needed, and all parts are reusable. Fitting is available in shapes such as connectors, unions, elbows, tees, crosses, and bulkhead connections in OD tube sizes from 1/8 to 2 inches. **Lenz Co.**, Box 1044, Dayton 1, Ohio.

Circle 469 on Page 131

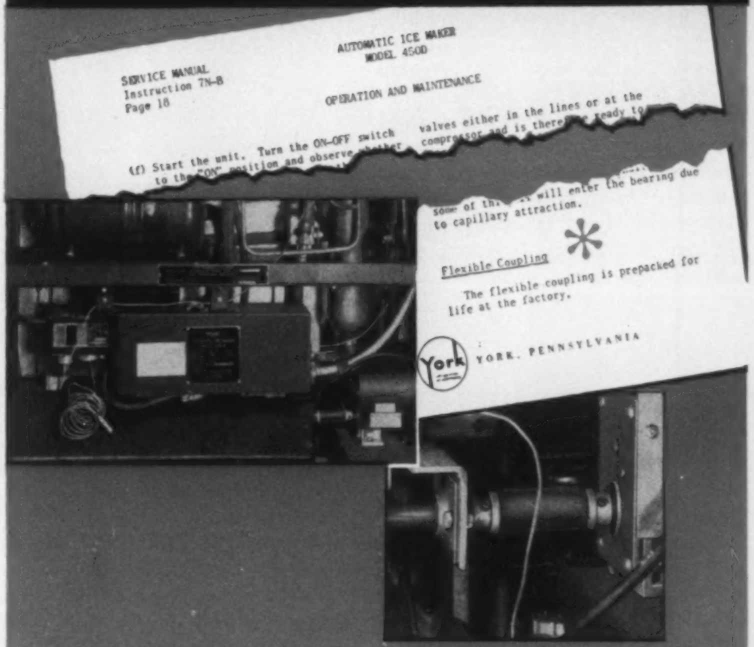


Industrial Motor

Item 470

Line of totally enclosed and explosion-proof motors is available from 1 to 500 hp. Features of the motor include recessed neoprene slingers on the output shaft, stainless steel connection and name plate, and shock resistant fan covers. Indexed leads and a balanced insulation system make the motor impenetrable to moisture and corrosive atmospheres. The oversize conduit

"...flexible coupling (an APEX universal joint) is prepacked for life at the factory..." *



SERVICE MANUAL
Instruction 7N-B
Page 18

AUTOMATIC ICE MAKER
MODEL 450D

OPERATION AND MAINTENANCE

(f) Start the unit. Turn the ON-OFF switch
to the "ON" position and observe whether

valves either in the lines or at the
compressor and is there ready to

some of th will enter the bearing due
to capillary attraction.

Flexible Coupling

The flexible coupling is prepacked for
life at the factory.

York
YORK, PENNSYLVANIA

Operation and maintenance instructions furnished with the York Model 450D Automatic Ice Maker are as crystal-clear as the 8,000 cubes the machine can provide every 24 hours. Included in the section on lubrication is a brief reference to the flexible coupling that joins the gear motor and the cam shaft: "The flexible coupling is prepacked for life at the factory . . ."

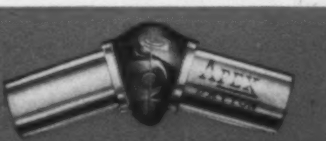
The flexible coupling is an Apex covered double universal joint, completely sealed to protect the joint and to provide clean, sustained lubrication.

Apex covered universal joints are used on a wide variety of industrial applications because they operate efficiently under wet or dry, corrosive or abrasive conditions. High overload capacity, lower deflection rate, superior fatigue resistance and high strength-weight ratio per size are other reasons why design engineers specify Apex universal joints to insure trouble-free service.

Catalog 28 will show you how Apex universal joints can help make yours a better product. Write, on your company letterhead please, for your copy.

1933 *A Quarter Century of Service to Industry* 1958

THE
APEX
MACHINE & TOOL CO.
1036 South Patterson Blvd.
DAYTON 2, OHIO



Phantom view of APEX covered universal joint which operates efficiently in wet or dry, corrosive or abrasive atmospheres, and in extremes of temperatures.

Circle 694 on Page 131

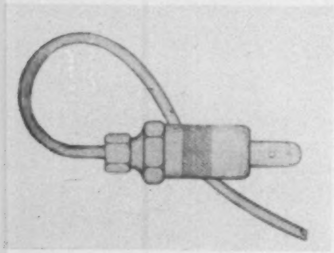
boxes provide easy installation. **Electric Motor Div., A. O. Smith Corp.,** Tipp City, Ohio.

Circle 470 on Page 131

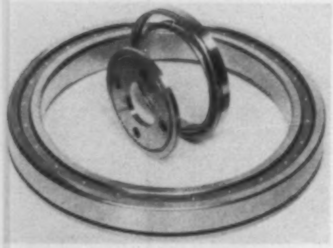
Poppet Valve

Item 471

Applicable in automatic machine tool equipment which is air operated, device can be actuated either directly or remotely. It is designed to release a measured amount of air from the pilot chamber of the air control valve upsetting a static pressure balance which causes a movement of the valve spool which in turn changes the directional flow through the control valve. The valve opens and closes only when the plunger is compressed, making it unnecessary to decompress the plunger before the control valve is energized in the opposite direction. **Lithibar Co.,** 345 W. 14th St., Holland, Mich.



Circle 471 on Page 131

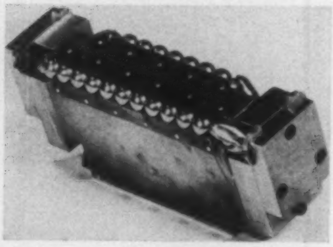


Radial Ball Bearings

Item 472

Applicable in portable air tools, magnetic clutches, and portable chain saws, ball bearings are designed in thin sections for space and weight savings. The bearings can be fabricated from numerous types of bearing material, including magnetic stainless steel, non-magnetic stainless steel, SAE 52-100, aluminum, bronze, K-Monel, and ceramics. They can be either the full complement or retainer type. **Ann Arbor Bearing & Mfg. Co.,** 815 Wildt St., Ann Arbor, Mich.

Circle 472 on Page 131



Sliding Bearing

Item 473

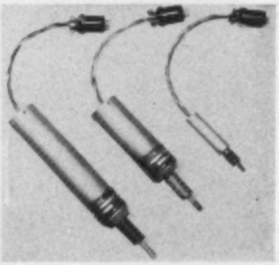
Unit is attached to and made a part of a moving unit such as a horizontal sliding table, to minimize breakaway friction and improve performance of the machine. The number of cartridges used depends on the length and weight of the moving part and the support needed. The balls are recirculated within the cartridge in the same manner as in the nut of ball screws. With the cartridges fixed in the moving part, the unit provides increased sensitivity and improved preloading. **Beaver Precision Products Inc.,** Clawson, Mich.

Circle 473 on Page 131

Transformer Transducers

Item 474

Line of differential transformer transducers designed for linear motion or displacement measurement can provide accurate measurement of motions as small as 0.000001 inch or over ranges as large as 0.4 inch. Unit includes an electrical connector, a bearing-aligned spring loaded plunger, and a threaded mounting shank with locking nut for precise positioning in the mounting fixture. Operating temperature range is −65 to +200 F. Transducer output can be measured with an ac millivoltmeter. **Daytronic Corp.,** 216 S. Main St., Dayton 2, Ohio.

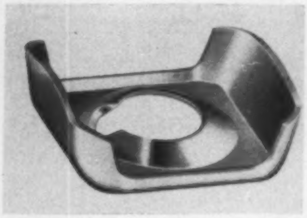


Circle 474 on Page 131

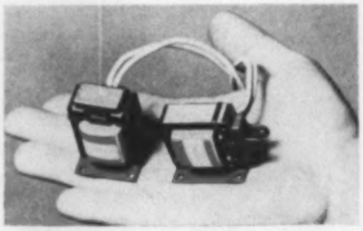
Self-Retaining Nut

Item 475

Tempered spring steel self-retaining lock nut is suitable for hopper feeding or for automatic insertion into cavities. Flared sides push into and retain the nut in the slot or cavity. The nut has a self-locking thread form which exerts a spring grip on the threads to resist loosening under vibration. Tightening torque of 10 lb-in. assures maximum locking action. Nut is available in zinc peen, cadmium, or plain finish. **Palnut Co.,** 61 Glen Rd., Mountainside, N. J.



Circle 475 on Page 131



Miniature Solenoid

Item 476

Miniature, multimillion-cycle solenoid features a "thirty second coil change" for fast coil replacement, eliminating the need of replacing a complete unit. Use of silicon steel field and plunger assemblies prevents residual magnetism and lowers eddy current and hysteresis losses. Heat treated, beryllium copper plunger guides and shading coil minimize noise and provide a long service life. Unit designated Series 01 produces $1\frac{3}{4}$ lb force at $\frac{1}{2}$-inch stroke, hold at $4\frac{3}{4}$ lb. Series 02 produces $2\frac{3}{4}$ lb force at $\frac{1}{2}$-inch stroke, hold at $5\frac{1}{2}$ lb. **Detroit Coil Co.,** Ferndale, Mich.

Circle 476 on Page 131

RECEIVING ENTHUSIASTIC ACCEPTANCE

VICKERS® New ¼″ Temperature and Pressure Compensated FLOW CONTROL VALVE

VICKERS
FLOW CONTROL & CHECK VALVE
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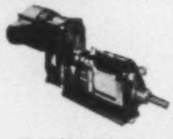

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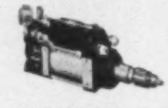

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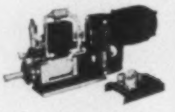

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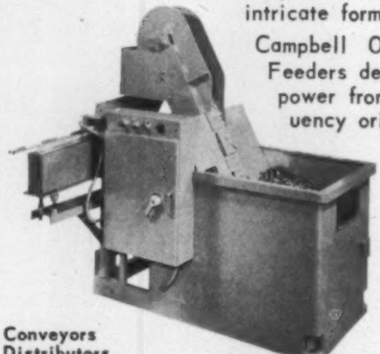

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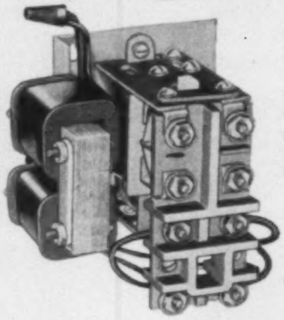

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AUTOMATION abstracts

PROGRESS IN AUTOMATION

By LEE D. MILLER
Associate Editor

AUTOMATION is the concept of doing things automatically. It can be considered wherever functions are to be performed—in homes, hospitals, offices, and factories.

Practical industrial automation can be said to be manufacturing, processing, or performing of services automatically to the degree indicated by the economics at the time. This is the type of automation which can actually make things available to a user at a price he can pay. Practical industrial automation is of most interest to industrial people, and this discussion will therefore be about its progress in the United States.

Automation does not require that mass production be an integral part. Basically, mass production means simply the production of large masses or volumes of products; the term mass production can properly be applied to production by entirely manual means as well as highly automated means. It is, however, surely one of the grandparents of automation. Without the development and application of mass production techniques we would not have our present production and distribution pattern. It is primarily this pattern that has made it economically feasible to apply greater and greater mechanization and, finally, automation.

Mechanization, too, has thus been a necessary progenitor of automation. Without the know-how and hardware developed for progressive mechanization, the basic tools of automation would not be available. In fact, the relationship between mechanization and automation is often so intimate that it is difficult to draw a line of demarcation between them.

Many people have suggested that automation is denoted by the use of electronic components, feedback control circuits, or computers. It appears from actual practice that no such delineations are valid. Instead, the line between mechanization and automation seems to be drawn best by an evaluation of the number of routine human actions in each phase of the function being performed. Where the number of routine human actions is low, most of us would consider the operation

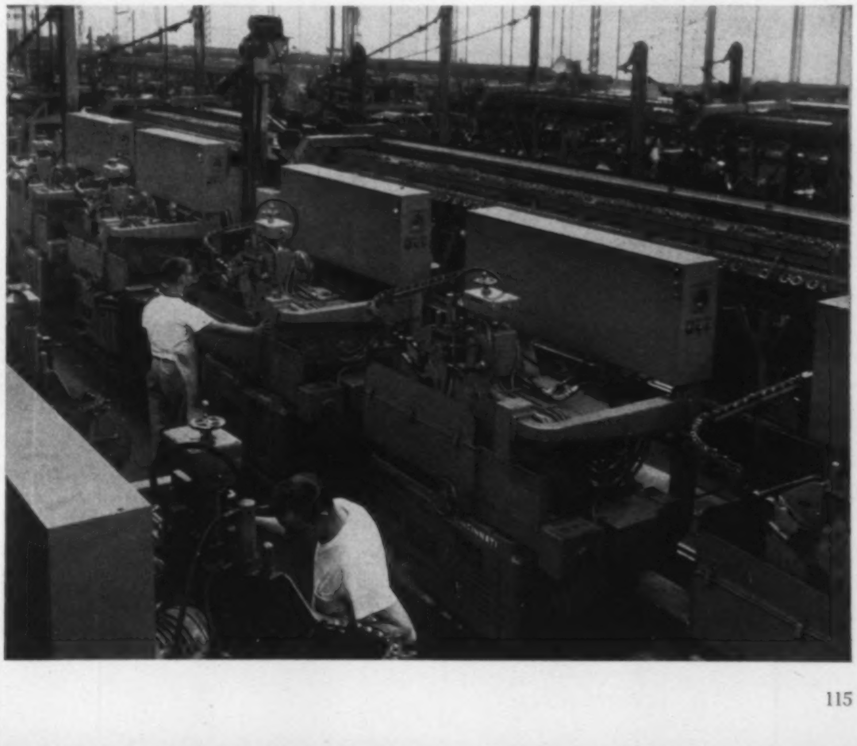

Fig. 1—Timken Roller Bearing Co. uses automated facility to produce 30 million bearings per year. In grinding operation shown, batteries of machines operating in parallel are fed from a common conveyor belt arrangement. When not needed, parts are recirculated and presented to the machines until they are accepted.

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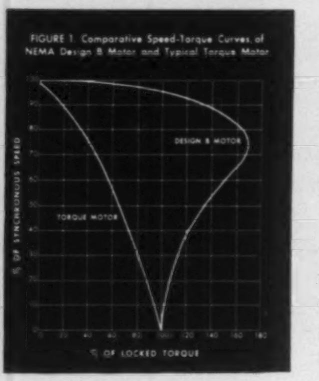
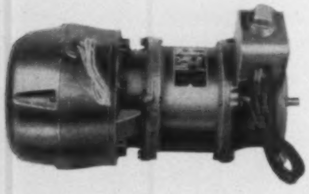


The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.



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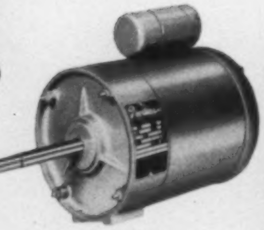

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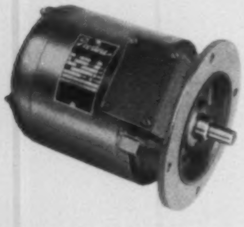

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Circle 700 on Page 131

to be an example of automation. Where the number of routine human actions is sizeable, we would regard it as an example of mechanization if mechanical aids are involved.

Evolutionary Concept

Automation progress, therefore, has been evolutionary in nature and intertwined and dependent upon developments in techniques and hardware related to antecedent concepts such as mass production and mechanization. It has not been a revolution or a total and radical change. It is the result of evolution in three basic areas. These areas are: 1. Acceptance of the concept. 2. Techniques for applying the concept. 3. Hardware to implement the concept.

Probably of greatest potential value is that management in job-lot industries and small companies is recognizing the concept. These are the industries and companies which most directly affect the majority of our people. It is here that possibilities exist for some of the most rewarding applications of automation.

Management acceptance of the concept of automation is also one of the areas in which a seemingly negative step has actually marked progress. This step has been the tempering of over-enthusiastic or extreme views about what automation can be expected to do. It has become more widely recognized that it is not a miracle solution to all industrial problems, and that pieces of automated equipment are only pieces of equipment.

Progress in acceptance of the philosophy by two other groups—organized labor and the general public—is worthy of mention. Although organized labor leaders have stimulated considerable talk about automation

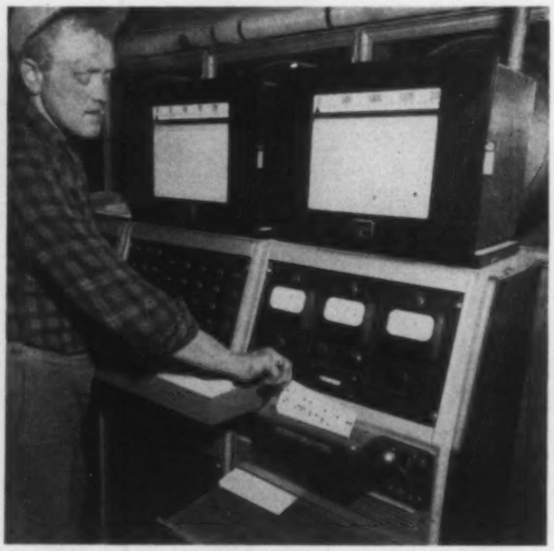

Fig. 2—Punched card control for automatic batching and mixing plant enables Cleveland Builders Supply Co. to produce 6 cubic yards of concrete every 2 minutes. Four aggregates, two cements, and water can be weighed out automatically for a single batch. To reset for new specifications operator inserts new card.

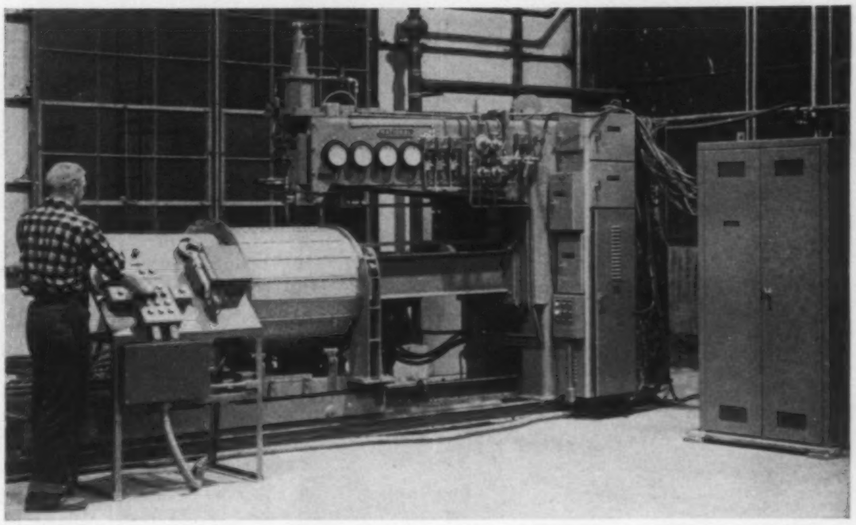

Fig. 3 — Automatic welding machine manufactured by National Electric Welding Machine Co. uses General Electric Co. punched tape numerical control to position workpiece and set weld time and temperature. Transverse and rotary motions are involved. Setup shows an 8 to 1 time ratio gain over previous manual method.

for indirect reasons, there have been no real strikes against automation in this country. Nearly all responsible labor leaders have indicated their agreement with the concept if their union members share in the benefits. To quote one of many such statements, Edward Swayduck of the Amalgamated Lithographers of America has said "Our union accepts automation. We don't fear progress, we welcome it." Official union actions also indicate this acceptance.

Many contracts, such as those of the UAW in the automotive industry, include agreements providing for wage increases based on increased productivity. Unions having such agreements have made it plain that such increased productivity should not be expected from a speedup on the part of the workers. People responsible for improving automotive production processes point out that such agreements are in essence an agreement to progressively automate.

Unions themselves have applied automation techniques in their own operations. In the national headquarters of the International Association of Machinists, for example, a data-handling system is used to process records on more than 900,000 members. With this system the union is reported to have reduced processing at the local level by 70 per cent and reduced its central staff from 148 to 96 employees.

The general public also has indicated its acceptance of automation. There have been no buyers' strikes against products because they are produced automatically. There has been a great deal of public discussion about automation. Congress, as the agent of the general public, has held several hearings on the subject. No need has been found by this body for punitive or restrictive legislation.

Representative Wright Patman is chairman of the subcommittee which held the automation hearings. He told the Second Conference on Manufacturing Automation last year that "Rapid advances in industrial processes and the continual installation of labor-saving devices are not new to us here in the United States; they have characterized our industry for decades. The result of this advancing technology has been rising productivity . . . One result of this efficiency has been to give us the world's highest standard of living . . . We have even managed as a nation to double, in the past ten years, the number of weeks spent on vacations, while increasing gross national product in terms of real goods and services by some 42 per cent." He then stated "Clearly, one of our first concerns as a nation is to preserve the setting and cultivate the forces which have made these things possible." He went on to say that th Government would of course be concerned if automation caused hardships.

Improved Techniques

There has been progress not only in the development and acceptance of the concept of automation, but also in techniques involved in its application.

Perhaps one of the most important advancements in this respect has been the increasing emphasis on a systems approach to industrial problems. This approach suggests that each operation in a system should be considered with regard to the whole system, and that a sound plan for the entire system should be used as a yardstick in evaluating proposals for individual operations. It does not mean that all parts of a system must be automated simultaneously. Nor does it mean that detailed plans for the entire system must be available before individual parts are installed. It does mean that costs of rebuilding individual parts at a later date to fit them into the system can be avoided. It means that general system considerations should be established.

In manufacturing it covers such things as: Desired sequence of operations. Combining or eliminating of operations. Product sizes to be handled. Rates of production. Types of handling between operations, and means for interlocking separate operations.

Application of the systems approach has made great progress in data-handling and data processing systems. One reason for this is that such systems until recently had a relatively low level of mechanization. Considerations of advanced equipment for such systems have therefore not had as many stumbling blocks as have

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Circle 702 on Page 131

manufacturing operations where highly mechanized equipment was already performing some of the functions.

Development of Standards

Another technique in which progress has been important to automation has been in the development and application of standards. This is related to the development of the systems approach, since compatibility is a goal of that approach and standards are, among other things, tools to gain compatibility. In the metalworking equipment field we now find such standards as JIC and NMTBA plus more general ones such as ASME, NEMA, and ASA. The Aircraft Industries Association has done a great deal of work on compatibility of various tape and card control elements. Admittedly these standards are neither the ultimate nor are they universally applicable, but they do indicate real progress in a fundamental technique.

In another area of standardization, progress in the building-block approach to equipment design has been important to small companies as well as the giants of industry. The application of this approach is a major factor in the increasing application of automation to small companies and job-lot operations. Without it, the alternative for automation has been custom-designed equipment that is generally out of the reach of such users. Big companies such as the automotive firms have also sought the benefits of this approach. Over the past several months, automotive people and machine builders have seriously discussed standards for machine units to be used as building blocks in construction of transfer machines.

Communication Of Ideas

Another technique which has received increasing emphasis is the solution of specific manufacturing problems through use of technical information from a wide range of sources. Co-ordination between different technical specialties—mechanical, hydraulic, pneumatic, electrical, and so on—has increased progressively. At the same time there has been increasing awareness that technical information and basic equipment developments can be applied from one industry to another. To illustrate, the manufacture of dry ice would usually be classed as a process industry and considered to have little in common with the printing industry. Yet a man in the printing business read in the journal I represent about an automated dry ice plant and found there the solution to one of his packaging problems. Such cross-breeding or cross-fertilization of information has shown that it can save sizeable amounts of engineering and other costs.

Pre-engineering Products

Greater recognition of the need for sound pre-engineering of products and equipment also marks progress in techniques for automation. Product designers are more widely applying techniques which make automatic production more feasible and more efficient: Standardization of similar components in families of products; tailoring of the product to suit production

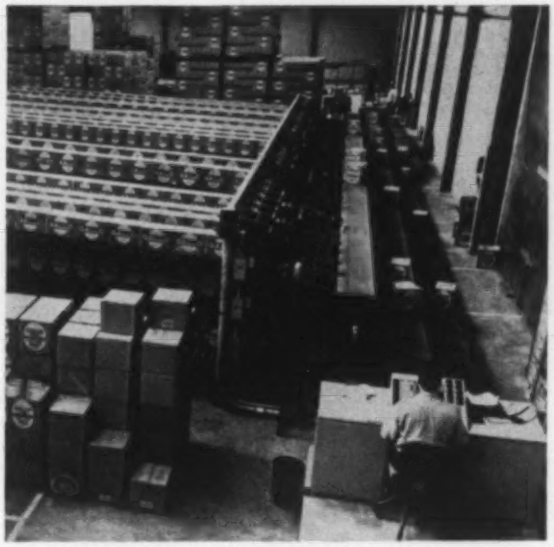


Fig. 4—Warehouse installation by Mathews Conveyer Co. provides storage for approximately 4000 cases of wine on banks of roller conveyors. Setting of switches on operator's console automatically releases desired number of cases of selected types to outgoing belt conveyor. Orders averaging 8 cases can be picked at a rate of 125 orders/hr.

processes; attention to the details of configuration which affect transfer, orientation, and feeding.

Manufacturing engineers and equipment designers find that more engineering is required before the fact and less after the fact. Correction of oversights at the bolts-and-nuts stage of an automation project instead of the paper-and-pencil stage may be disastrously expensive. Failure to consider improvements in existing manual or semiautomatic methods may lead to an overly costly operation.

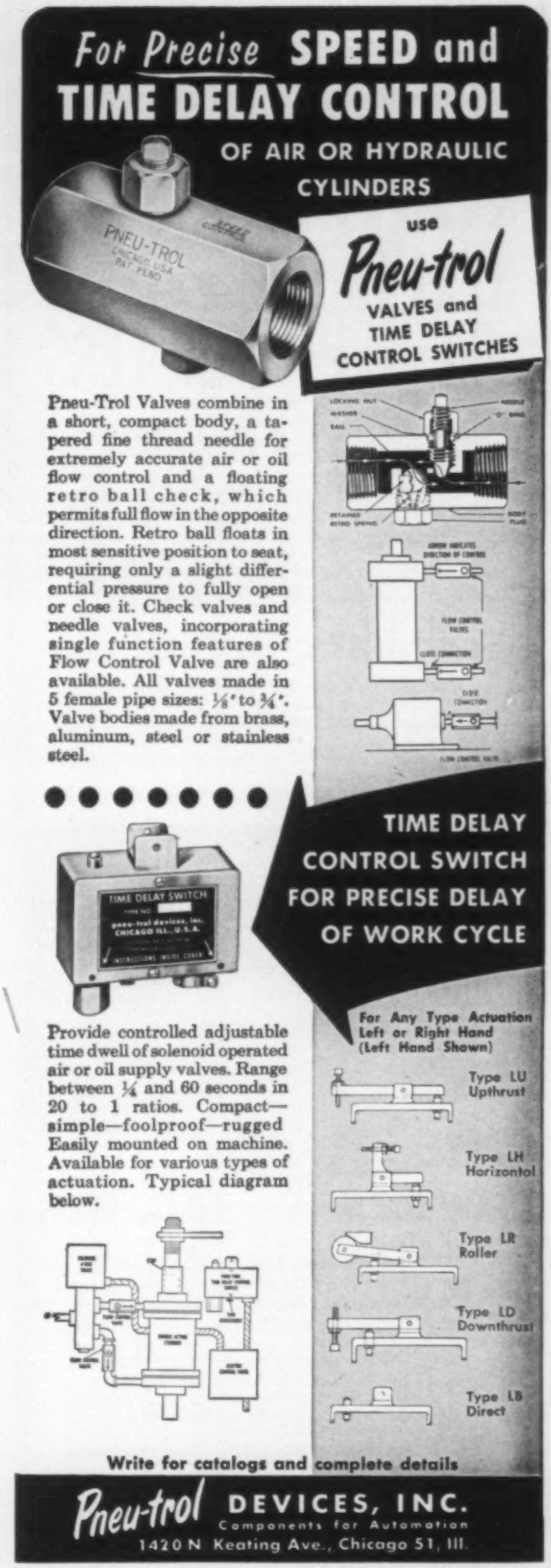
Hardware Developments

Improvements in industrial philosophies and techniques would be of little value if they found no concrete expression in hardware, i.e., the plants, equipment, and components which make our products. A few examples will suffice to indicate some of the trends.

Activities at the Timken Roller Bearing Co. plant in Bucyrus, Ohio, are illustrative of present trends in automation and can serve for comparison with some foreign developments as well as with earlier American practice. This plant can produce 30 million roller bearings per year. Cones (inner races) and cups (outer races) are made in the plant from hot-rolled steel tubing. Rollers and the cages to maintain roller spacing are shipped in from other plants.

From the time the cones and cups are cut from raw material until they leave in a shipping container they are moved automatically.

This plant represents a specialized facility built to apply automation to production of a stable product configuration. Fourteen varieties of cups and cones constitute 80 per cent of the production volume. Use of automated production facilities, plus the acceptance of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Circle 705 on Page 131

standardized bearings by the users, helped make it possible for the cost of a set of Timken bearings for 1957 automobiles to be lower than that for similar bearings made in other Timken plants.

A report on a much-praised Russian automatic factory for bearing production gave figures which indicate its production is about 35 bearings per shift per worker. Production at Timken-Bucyrus is about 192 bearings per shift per worker. One of the reasons for this high productivity is evident by comparing the automatic handling in this plant with previous Timken practice. On one cup model, previously made in another plant, there were 89 separate handlings, and each cup was touched by 100 different people to complete the process.

To obtain desired production quantities operations at Bucyrus are performed by batteries of machines operating in parallel fashion, *Fig.* 1. Unique conveyor systems serve the batteries by acting as combined storage and demand-feeding systems. A belt conveyor running the length of the battery of machines is tilted so that as a workpiece travels along on the belt it may roll into any machine loading chute that is not full.

Card And Tape Control

A plant of Cleveland Builders Supply Co., Cleveland, Ohio, illustrates the application of automation in an entirely different industry. The control center of this concrete batching plant uses a punched card system, *Fig.* 2, to automatically weigh out desired mixes. Six different aggregates and three different cements are stored in large bins above the batching equipment. Automatically operated gates and screw conveyors control flow of water and materials into weighing hoppers. The operator inserts into a card reader a punched card indicating the desired quantity of each ingredient for a batch. He then throws a switch and the batch is automatically weighed out.

Features of this installation are typical of those obtained by punched card control on all types of equipment. Commands can readily be varied from cycle to cycle, are consistently given at a high level of accuracy, and the operations can be performed faster than with manual control. Provision is included for manual control when desired.

The automatic spot welder in *Fig.* 3 is an example of numerical control through a punched tape medium. In this machine a fixture holds a cylindrical workpiece, rotates, and moves longitudinally to position the workpiece with respect to the welding electrodes. Commands punched in a tape determine the rotary and longitudinal positioning of the workpiece, weld heat, and weld time. Accuracy of the system is said to be within plus and minus 1/64-inch on both rotational and longitudinal motions. The change to an automatic machine from the previous manual operation resulted in an 8 to 1 time ratio gain.

This type of development has been of high interest in many industries, and numerical controls have also been applied to production equipment for drilling, riveting, turning, contour milling, billet rolling, and punching. Developments in numerical controls are part of the reason managements of small-lot production operations are more enthusiastic about automation than they used to be. Such controls, in many cases, are practical solutions to problems that have plagued such companies for years.

Warehousing

An interesting type of development in a nearly universal industrial activity is shown in *Fig.* 4. This is an automated order picking arrangement for a warehouse. Cases of wine are stored on 66 roller conveyors arranged in three banks. Release of cases from each conveyor to an outgoing belt conveyor is controlled by escapements. An operator sets switches on the control console for the types and numbers of cases required to fill an order. After he presses a *Start* button the system automatically releases and counts cases in a controlled sequence. Selector switches allow changeover between several storage conveyors for a single commodity with no resetting required in the count circuit. Approximately 4000 cases can be stored, and orders averaging 8 cases each can be picked at a rate of 125 per hour.

Static Controls

An example of development in the area of control components is that of static controls. These systems employ magnetic amplifiers, which are a type of saturable core reactor. In these devices, a change in current in control windings changes the magnetic fields in associated cores and effectively controls the flow of current in load windings. The *On-Off* action available with these devices can be accomplished without any mechanical movement. They can thus avoid contact troubles and other mechanical difficulties. Though their present use is subject to many limitations, they have proved especially worthy of consideration where logic operations or a large number of switching operations are to be performed.

Summary

Progress in automation has been evolutionary. This progress has included evolution in the concept, in its acceptance, and in techniques and hardware for applying it. The concept is related to, but different from, mass production and mechanization, and its acceptance has been evidenced by management, organized labor, and the general public.

Some of the techniques important in the application of automation are the systems approach, standardization, use of building-blocks, cross-breeding of ideas, and more pre-engineering of products. Developments in these areas have led to, and been dependent on, developments in plants, equipment, and components. A few of the many hardware developments have been mentioned to illustrate some of the interesting steps marking automation progress in the United States. Its continued advancement is our hope for maintaining or improving our standard of living.

From a paper entitled "Automation Progress in the United States" presented at the Semiannual Meeting of the American Society of Mechanical Engineers, Detroit, June 1958.

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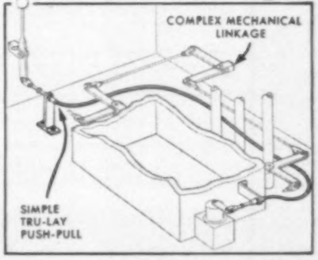

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Positive Remote-Action and Flexibility, together with Precision and Long Life, explain why TRU-LAY PUSH-PULLS serve designers and users equally well in improving machine operations, whether the application is on such severe service jobs as Bulldozers, Power Shovels and Steel Mill Machinery, or on such light duty work as Photographic Equipment, X-Ray or Business Machines.

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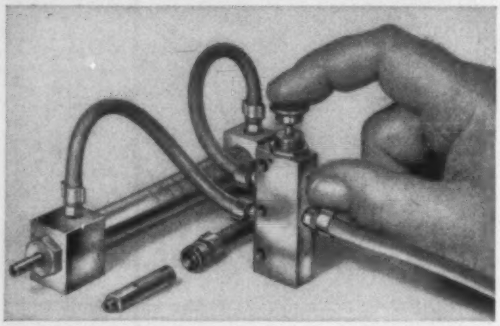

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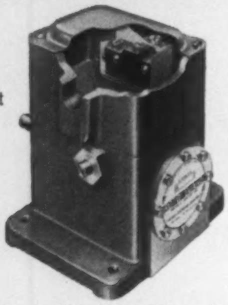

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AUTOMATION

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By C. W. S. Parsons, instructor in production planning, processes, and tooling, California State Polytechnic College; 366 pages, 6 by 9 inches, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$8.00 postpaid.*

As background information, text examines factors in metal removal such as the work material, tool material, tool life, horsepower, etc. Detailed cost-estimating analysis for various machine tool operations are then presented. Applications discussed include drilling, boring, shaping, milling, turning, and broaching. Tables and curves are included to give values for factors on which estimates can be based.

TECHNIQUES OF MAGNETIC RECORDING

By Joel Tall; 472 pages, 5½ by 8¼ inches, illustrated, clothbound, published by Macmillan Co., New York; available from AUTOMATION; *$7.95 postpaid.*

General chapters in the first part of this book discuss history, simplified theory, and fundamentals of magnetic recording as well as media, drive mechanisms, and techniques in erasing, maintenance, outdoor recording, editing, and rerecording. Final chapters discuss applications in various fields of endeavor.

IDEAS, INVENTIONS, AND PATENTS

By Robert A. Buckles; 270 pages, 5¾ by 9 inches, illustrated, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$5.95 postpaid.*

The primary purpose of this book is to help technically trained people to acquire a better understanding and appreciation of patent matters. The author indicates facts he considers important to proper patent and trademark protection and points out how they may be recognized, evaluated, and used effectively.

ELECTRONIC DESIGNERS' HANDBOOK

By Robert W. Landee, general manager and chief engineer, Potter Pacific Corp., Donovan C. Davis, section director, engineering, Gilfillan Bros. Inc., and Albert P. Albrecht, assistant director of engineering, Gilfillan Bros. Inc.; 1040 pages, 6 by 9 inches, clothbound, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$16.50 postpaid.*

Volume provides fundamentals and data needed in design of electronic equipment. Coverage in 23 sections extends from vacuum tubes, transistors, voltage amplifiers, and power amplifiers to principles of feedback, computer and servomechanism techniques, and network analysis. Frequently used circuits and practices are an integral part of the presentation.

AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D.C.

APPARATUS FOR CONVEYING MAGNETIZABLE SHEETS

Sheets traveling on a conveyor pass between upper and lower magnetizable rolls. By energizing either the upper or lower roll, the sheets are directed to either an upper or lower conveyor for transport to two separate storage units. Patent 2,814,398 by William E. Coleman and George H. Rendel, assigned to United States Steel Corp.

SACKED-MATERIAL CONDITIONING MACHINE, INCLUDING OPPOSED VIBRATING CONVEYOR BELTS

Lumpy sacked material passes between upper and lower conveyor belts. Driven eccentric rollers disposed against the inner surface of each conveyor belt alternately urge the belts toward each other, breaking lumps in the sack of material. Patent 2,815,177 by Charlie J. Raynor, assigned to Planters Cotton Oil & Fertilizer Co.

UNSCRAMBLER FOR EMPTY CANS

Empty cylindrical cans, open at one end, are conveyed in a horizontal position on a conveyor which is narrower than the can and supports the can between the ends. Heavier closed end causes can to topple from conveyor against diverging side support which guides can and deposits it open end up. Patent 2,815,845 by John Albertoli.

COUNTING MECHANISM

Conveyed articles disrupt pressurized stream of gas directed at a pressure-sensitive device and cause device to actuate an electrically operated counter. Patent 2,816,708 by Pearson T. Menoher, assigned to Owens-Illinois Glass Co.

BOTTLE SORTER

Photoelectric cell causes a solenoid-operated gate to swing across the path of a bottle on a conveyor diverting the bottle to one of two sorting paths. Patent 2,821,302 by Gerald I. Fowler and Robert R. Wilson.

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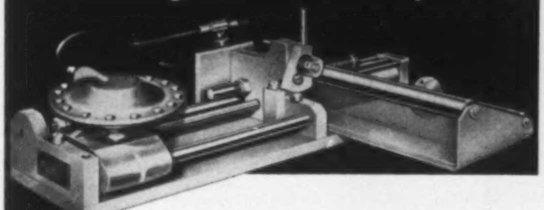

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Circle 710 on Page 131

CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Accounting, 5-60
Actuators, hydraulic, 3-86
Adhesive bonding, 8-49
Adiletta, J. G.
  Comparing Machine Cost and Time Factors, 5-55
Air blending, 3-14
Analysis, instrumental methods, 3-156
Armstrong, N. E.
  Automatic Techniques of Oil and Gas Production, 8-57
Assembly,
  automated, 3-9; 5-10
  diode sealer, 4-10
  electronic components, 3-58
  gravity conveyors, 6-40
  of darts, problem, 6-134
  small motors, 3-9
  sponge mops, 4-17
  typewriters, 7-55
Automation,
  and labor, 3-12; 4-150; 8-115
  and management, 5-156; 8-115
  and paperwork, 3-65
  and plant size, 4-147
  and the community, 4-150; 6-10
  and the economy, 3-154; 7-12; 8-9, 115
  for small-lot producers, 3-54; 7-53; 8-115
  importance of handling, 5-40
  in automobile industry, 4-12
  in coal industry, 6-12
  in colleges, 4-10, 17
  in food industry, 5-14; 8-12
  in industrial instruments, 4-12
  in petroleum industry, 8-57
  in pipeline industry, 4-10
  in railroads, 6-9
  in refineries, 7-109
  in textile industry, 7-11
  movies on, 5-19
  numerical positioning control, 4-60
  numerically controlled machine tool system, 6-34
  philosophy, 3-154; 6-121
  planning for, 3-54; 6-121; 8-12
  trends in, 6-121; 8-115
Automobile,
  bodies, 3-93
  glass manufacture, 8-25
  parts manufacture, 5-43
  seats, 3-93

B

Bakery operations, 8-12
Baking, carbon brick, 8-48
Balance checking, 8-62
Bale, A. G., Jr.
  Automatic Batching System Combines Flexibility and Portability, 5-76
Batch weighing, 5-76; 7-34
Bauer, J. H.
  Production Line Welding, 5-68
Bearings, roller way, 4-28
Binding paper rolls, 6-49
Blending control, 3-94
Blending dry materials, 3-14
Blower wheels, 5-74
Bolz, R. W.
  Directly Co-ordinated, edit., 8-33
Breadwrapping machines, 5-55
Browning, E. H.
  Strip Mill Uses Automatic Programmed Control, 6-64
Bulk handling, 3-16, 94; 5-76; 7-34

C

Cartons problem, 5-142
Casting production, 8-38
Center of gravity determination, 8-62
Centralized control, 6-9
Circuits, pneumatic, 7-67
Clamping mechanism, 7-65
Clark, S. C.
  Numerical Positioning, 4-60
Cocks, E. H.
  Automatic Spray Painting of Electrical Conduit, 3-69
  Considerations in Selecting Automatic Painting Equipment, 8-66
Coding mail, 5-12
Communication type controls, 3-82
Computers, 5-68
  analog, 3-20; 7-14
  auto guidance, 4-39
  for absorbing articles, 4-14
  for inventory control, 3-10
  for process control, 5-22
  oil and gas production, 8-57
Conduit painting, 3-69
Continuous weighing, 7-36
Contour machining, 7-28
Contouring control, 7-57
Controls,
  atmosphere in furnace, 4-81; 5-46
  auto steering, 4-39
  building blocks, 6-34
  by computers, 8-57
  contouring, 7-57
  design to be foolproof, 3-43
  electrical, 7-44
  electrohydraulic, 6-69
  electropneumatic, 3-33, 78; 5-91
  fuel production, 8-16
  furnace, 8-10
  gaging, 3-73
  glass melting, 3-16
  heat treating, 5-46; 8-64
  hydraulic drive, 7-52
  interfloor conveying, 4-69
  length, 8-55
  machine tools, 3-27; 4-142
  magnetostrictive motor, 4-73
  maintenance system, 7-14
  mechanical pneumatic, 3-78
  nail feeder, 3-89
  numerical, 5-9; 7-25, 57
  numerical controlled machine tools, 6-34
  of gas compressors, 8-57
  of material level, 8-70
  of presses, 3-146
  of pumps, 8-10
  oil and gas production, 8-57
  optimizing, 5-71
  panels, 3-10
  pipeline surge, 7-14
  plug-in, 3-82
  programmed tractor, 4-81
  pulp consistency, 8-70
  punched card, 5-79; 6-64; 8-9
  railroad traffic, 6-9
  refinery, 7-109
  remote, 5-91; 6-58
  rolling mill, 6-64
  sequencing, 6-69
  servo, 8-71
  static, 3-75; 8-12
  stepping switch, 3-89
  temperature, 7-16
  theory, 4-139
  traffic lights, 6-10
  transistors in, 6-10
Converter housing manufacture, 7-64
Conveyors,
  bottles, 5-12
  bulk material, 8-54
  drive system, 8-16
  interfloor handling, 4-69
  magnetic, 4-12
  making gravity type, 5-40
  overhead, 4-57; 5-10
  package, 5-60
  paper rolls, 6-49
  steel belt, 4-56
  transfer devices, 5-19; 7-61
Cost estimating, 5-52, 55, 60
  weighing, 7-34
Cutoff,
  slab, 7-72
  tubing, 3-60
Cutoff and chamfer, problem, 8-126
Cutting,
  tube problem, 7-122
  wire problem, 8-126
Cylinders, pneumatic interlocked, 5-92

D

Damschroeder, E.
  Handling Devices Speed Washer Cabinet Production, 7-41
Data processing, 3-10, 16, 65; 4-139; 5-68, 156; 6-10; 7-10; 8-14
  abstracts articles, 4-14
Data recording, 7-12
Data storage, 3-24; 5-24; 8-12
Depreciation, 5-51, 60
Design,
  for automated production, 3-58
  for foolproof automation, 3-43
  for production, 4-139; 7-118
  numerical positioning control, 4-60
  of handling systems, 5-40
  of interfloor conveying system, 4-69
  of packaging machine, 8-42
Detectors,
  flow, 8-14
  page alignment, 8-55
Dexter, R. G.
  Estimating Special Equipment Costs, 5-52
Differential transformers, 5-79
Digital,
  computing systems, 4-139
  display device, 7-10
  recording, 4-139
Drilling, 3-22; 8-64
  numerical control, 8-45

E

Economics, 8-9
  numerically controlled line, 6-34
Education, 7-25
  of automation, 4-10
Ejecting work-in-process, 8-55
Elder, J. C.
  Basic Electrical Controls, 7-44
Electrical,
  baking, 8-48
  controls, 7-44
  elementary diagrams, 5-147
  feedback, 7-72
  keyboards, 8-18
  leveling device, 8-18
  machine control, 4-82; 5-147
  network synthesis, 6-130
Electronics,
  assembly, 3-58
  building blocks, 6-34
  construction system, 4-22
  data processing, 6-10; 8-12
  designers' handbook, 8-122
  future growth, 6-10
  maintenance control, 7-14
  paging system, 8-18
  postal equipment, 5-12
  semiconductor manufacture, 5-10
  testing devices, 6-19
  traffic control, 6-10
Engineering,
  processing, 6-121
  productivity, 4-139
  special machines, 5-55
Engler, W. E.
  Versatile Interfloor Handling, 4-69
Equipment,
  cost estimating, 5-52, 55, 60
  replacement, 5-51
Estimating, 5-52, 55, 60
  machining costs, 8-122
Everstine, R. L.
  Transferring Racks Automatically, 7-61
Experimentation, automatic, 5-71

F

Failsafe controls, 3-43
Fasteners, 5-10
Feedback control, slab cutoff, 7-72
Feeders,
  control, 3-89
  for discrete parts, 5-82
  for setscrews, 4-77
  for small parts, 7-53; 8-10
  molding press, 5-59
  pneumatically controlled, 3-94
Feeding,
  discrete parts, 5-82
  plastic rope, 5-59
  sheet metal, 5-89
  tablets, 8-42
  thin materials, problem, 6-135
Filmer, T.
  Feedback Controlled Steel Slab Cutoff, 7-72
Finishing, 8-66
Fixtures, for milling machines, 7-53
Floats, 4-56
Flow control, 4-22
  magnetic tape recording, 5-50
Food processing, 8-12, 49
Forming,
  sheet materials, 3-93
  titanium hemisphere, 8-30
Foundry, automated, 8-38
Fuel production, 8-16
Functional testing, 3-61

G

Gaging,
  combined in-process and post-process, 3-73
  components problem, 4-140
  in control, 5-144
  in-process, 4-24, 92; 6-16
  thickness, 8-65
Garrison, J. L.
  Applying Infrared Analyzers to Control Furnace Atmospheres, 6-46
Gear production, 4-91
Gibbs, R.
  Orientation by Rotation, 4-77
Glass manufacture, 8-25
Goldberg, R., 6-25
Gravity conveyor manufacture, 5-40
Grease, multipurpose, 7-16
Grinding,
  control, 3-73
  piston rings, 4-80
Guidance control, of autos, 4-39

H

Hadekel, R.
  Hydraulic Control of Automatic Machinery, 4-82; 6-69; 8-71
Handling, 3-159
  banking, 4-56
  between machines, 5-88
  bottles, 5-12
  bulk materials, 3-16, 94; 5-76
  by programmed tractor, 4-81
  by tractor, 8-20
  cases, 3-92; 5-30
  cigarettes, 4-90
  concrete ingredients, 5-76
  conveying, 4-57
  for casting, 8-38
  for painting, 4-57
  for plating, 7-61
  for woodworking, 5-88
  garment materials, 5-60
  in multislide press, 7-60
  in transfer machine, 4-50
  magnetic, 5-12
  magnetic fixture, 8-64
  mail, 5-12
  pallets, 6-14
  paper broke, 8-70
  paper rolls, 6-49
  pharmaceuticals, 8-42
  piling bulk materials, 3-85
  pistons, 4-56
  plumbing fittings, 5-10
  scrap, 4-9
  sheet metal, 5-89; 7-41
  tin plate, 8-54
  to machine tools, 4-91; 7-53
Harris, S. E.
  Plant Develops Own Pharmaceutical Packager, 8-42
Heat treating, 6-46; 8-64
Honing, 4-14
Hydraulics,
  actuators, 3-86; 8-71
  automatic sequencing, 6-69
  components, 7-113
  control, 6-69; 7-113; 8-71
  converted machine tool, 4-81
  drive system, 7-52
  feedback, 7-72
  for machine tools, 7-25
  press system, 3-75
  servo systems, 8-71
  systems engineering, 4-82; 8-71

I

Idling, in hydraulic systems, 4-82
Indexing,
  assembly machines, 7-55
  devices, 3-86
Industrial engineering, 5-55
Information handling, 3-65; 6-10
Infrared analyzers, 6-46
Infrared heating,
  applications for, 8-49
  oven design factors, 8-49
  source characteristics, 8-49
Inspection,
  automatic, 5-144
  closed circuit television, 6-58
  electronic, 6-16
  photoelectric, 5-12
  radioactivity, 7-12
  testing, 3-61; 7-28
Instrumentation, in refineries, 7-109
Integrated,
  data processing, 5-68
  handling, 4-91
  standard machines, 6-57
Integrating automatic operations, 6-57
Intensifiers, air-hydraulic, 7-67
Interfloor handling, 4-69
Interlocking, pneumatic cylinders 5-92
Inventions, 6-25

J

Jessup, W. F.
  Integrated Machine Tool Systems, 4-50

K

Kerstukos, A.
  Optimizing Process Operations, 5-71
Krupp, P. H.
  Infrared Radiant Heating Improves Manufacturing Processes, 8-49

L

Lathes, numerical control, 4-60; 7-57
Layout and dimensioning, 6-130
Leasing, machine tools, 7-12
Liquid filling, 4-30
Load cells, 3-94
Load sensing devices, 7-37
Loading, 3-92
Logic devices, 7-44

M

Machine tools,
  boring, 8-18
  card controlled, 4-60
  control, 3-73, 82
  fixture for, 7-53
  grinding, 4-73, 80
  hydraulically operated, 7-25
  integrated systems of, 4-50
  lathe, numerically controlled, 7-57
  leasing, 7-12
  presses, 5-43, 74
  rotary index, 4-39
  tape controlled, 4-60; 5-9; 6-34
  tracer controlled, 4-81; 7-28
  transfer, 7-64
Machines,
  assembly, 4-10
  boring, 7-18
  bread wrapping, 5-55
  carton stacking, 6-60
  circuit board, problem, 3-51; 6-135
  compression molding, 5-59
  cutoff, 3-60
  design trend, 6-121
  drilling, 3-92, 93
  estimating costs of, 5-52, 55
  extrusion press, 6-12
  honing raceways, 4-14
  molding rubber, 7-9
  numerical control, 4-60; 5-9
  nutsetter, 4-17
  packaging, 8-42
  paper laminating, 7-52
  pneumatic, 3-78
  powder rolling, 5-10
  scrap shear, 4-9
  steel strapping, 7-16
  tape controlled, 3-57
  testing, 3-61; 6-19
  textile, 7-111
  welding, 5-14
  wire coating, 4-80
MacWilliams, R. W.
  How to Figure Payoff, 5-60
Magnet, belt conveyor application, 4-12
Magnetic,
  handling devices, 4-12
  recording techniques, 8-122
  rubber, 5-12
  tape recorders, 3-24; 5-9; 6-50
Magnetostrictive actuation, 4-73
Maintenance, control system, 7-14
Management for engineers, 6-130
Manufacture of,
  automobile bodies, 3-93
  automobile seats, 3-93
  blower wheels, 5-74
  cans, 8-54
  carbon brick, 8-48
  cigarettes, 4-90
  control components, 6-34
  converter housings, 7-64
  copper coated wire, 4-80
  engine block castings, 8-38
  gasket retainers, 6-57
  glass, 8-25
  gun shells, 3-9
  jet engine casings, 5-79
  magazines, 8-55
  metal parts, 6-130
  missiles, 8-62
  motors, 3-9
  paper, 8-70
  pharmaceuticals, 8-42
  pipe, 3-92
  piston rings, problem, 4-140
  plastic items, 8-49
  plastic pellets, 8-65
  pulp insulation, 6-58
  railroad car wheels, 4-12
  road machinery, 4-39
  shoes, 8-49
  textiles, 7-111
  textile belting, 8-49
  washer baskets, 6-68
  washer cabinets, 7-41; 8-49
  wood products, 5-88
Manufacturing functions in small-lot automation, 3-58
Manufacturing team, 8-34
Materials handling, 3-16, 24, 156; 4-69, 81; 5-10, 30, 156
  application of principles, 5-40
Maynard, A. F.
  Automation for Small-Lot Producers, 3-54
McCabe, L. E.
  Automation for Small-Lot Producers, 3-54
Measurement, electrical, 3-156
Measuring, ultrasonic, 4-22
Memory,
  devices, 4-20; 5-35; 8-12
Milioto, R. P.
  Automation for Small-Lot Producers, 3-54
Milligan, W. E.
  Automatic Weighing and Blending, 3-94
Mohr, P. A.
  Instrumentation Applications of Magnetic Tape Recording, 6-50
Moisture control, problem, 3-57
Mold production,
  foundry, 8-38
Molding,
  plastics, 3-12, 75; 5-147; 6-59
  rubber, 7-9
  wax tires, problem, 6-135
Moritz, J. M.
  Basic Pneumatics for Automation, 3-78; 5-92; 7-67
Motion indicator, 7-16
Motors,
  reversing problem, 4-140
  starting, 7-44
  stopping, 7-44

N

Nail feeding, 3-89
Numerical control, 3-27; 4-60; 5-9; 7-25, 57
  in positioning, 5-79; 8-45
  machine tool system, 6-34
  milling machine, 4-142
  of rolling mill, 6-64
  systems, 7-118

O

Optimizing, controllers, 5-71
Order picking, 5-68
Oscillating blade, parts selectors, 5-82
Oscillating box, parts selectors, 5-86
Ovens, plastic finishing, 3-14

P

Package conveying system, 5-60
Packaging, machines, 3-12; 8-14, 42
  plastic blister, 8-14
Packing, garment, problem, 3-51
Paging system, 8-16
Painting, 8-66
  conduit, 3-69
  systems, 4-57
Painting fixture, magnetic, 8-64
Pallet unloading, 5-68; 6-14
Parts selectors, 5-82
  manufacturers of, 5-82
Patents, 8-122
Payoff calculations, 5-60
Philosophy, automation, 5-46
Physics, basic, 5-156
Pilot devices, 7-44
Pin-type parts selectors, 5-82
Pipeline protection, 7-14
Plating machine system, 7-61
Pneumatic,
  combination circuits, 7-67
  feedback, 7-72
  machine systems, 3-78, 146
  motion control, 3-79; 5-92
Positioning,
  hydraulic, 6-69
  magnetostrictive device for, 4-73
  numerical control, 4-60; 8-45
  pneumatic, 3-78
  rotary table, 5-79
  servo, 8-71
Powder metallurgy, 3-20
Power devices, 7-44
Presses, 5-74
  automated, 5-89
  control, 3-75
  extrusion, 6-12
  feeding, 5-89
  feeding, problem, 5-142; 7-122; 8-126
  multislide, 7-60
  multistage die set, 8-30
  transfer devices, 7-60
  wheel bolster, 5-43
Pressure, magnetic tape recording, 6-50
Printing device, 7-20
Process,
  annealing furnace atmosphere, 4-81
  control, 5-71
  copper coating of wire, 4-80
  engineering, 5-74
  extrusion, 6-12
  instruments, 4-139
  metal fabricating, 6-130
  plastic molding, 3-12
  powder metallurgy, 3-20; 5-10
  refinery, 7-109
  rubber molding, 7-9
  weighing, 7-34
Product design, 5-74; 8-34
Production engineering, 8-34
Programming, 3-57; 5-24
  electric switch, 8-9
  numerically-controlled line, 6-34
  rolling mill, 6-64
  tractors, 4-81
Proportioning, 3-94
Punched cards, 6-64
  control of machining, 5-79
  in data processing, 3-65; 6-10
  in inspection, 4-20; 8-9
Punched tapes, 8-9
  machine control, 7-57; 8-45

Q

Quality control, 3-61; 5-144

R

Radiation gages, 6-10; 7-12, 16; 8-65
Radio tone system control, 6-10
Radioisotopes in industry, 6-10
Railroad traffic control, 6-9
Recording physical functions, 6-50
Rectifier, silicon controlled, 5-10
Relays, control, 3-82
Replacement, equipment, 5-60
Road machinery manufacture, 4-39
Roberts, C. C.
  Feedback Controlled Steel Slab Cutoff, 7-72
Roll forming, 5-74
Rotary,
  stepping switch application, 3-89
  switch problem, 3-51
Rotating barrel parts selectors, 5-82

S

Safety devices, 3-159
Sammons, C. J.
  Typewriter Subassembly, 7-55
Scales, weighing, types, 7-39
Schematic diagrams, how to read, 4-139
Scrap sheas, 4-9
Screwdriving, 4-77; 5-16
Semiconductors, 4-148
Sensing,
  heads, problem, 8-126
  linear speed, problem, 4-140; 7-123
  systems, 4-139
  table positioning, 5-79
Sequencing, pneumatic systems, 5-92
Servo,
  actuators, 7-57
  auto guidance, 4-39
  controlled machine tools, 7-25
  systems for velocity and position control, 8-71
  valves, 8-71
Sifting, sonic, 5-27
Sign typewriter, 3-22
Smith, E. W.
  Plug-Ins Provide Versatile Machine Control, 3-82
Sorting,
  electronic mail, 5-12
  gaged parts, 3-73
  mixed parts, problem, 6-134; 8-127
Souler, R. A.
  Dimensional Controlling Systems, 3-73
Speed,
  changing, 7-44
  magnetic tape recording, 6-50
Spinning, 8-30
Spray painting, 3-69; 8-66
Staley, J. A.
  Integrating Standard Machines to Perform Special Jobs, 6-57
Standards,
  pneumatic control systems, 7-118
  tubing color code, 6-4
Starters, motor, 7-44
Stepping switches, 3-89
Stewart, H. L.
  Basic Pneumatics for Automation, 3-78; 5-92; 7-67
Stiles, J. W.
  Package Conveying System, 6-60
Storage systems, 4-50; 6-14
Storing, 5-68
Subassembly, automation of, 7-55
Superfinishing control, 4-92
Suuronen, E.
  Automation for Small-Lot Producers, 3-54
Systems,
  approach to automation, 3-54
  hydraulic, 4-82; 6-69
  integrated machine tool, 4-50
  maintenance control, 7-14

T

Tape,
  eraser, 6-16
  magnetic recording, 6-50
  punched, 7-57
Tape controlled,
  machine tool system, 6-34
  milling machine, 5-9
  positioning machine motions, 4-60
  punching machine, 3-57
  testing machine, 3-63
Tape programmed milling machines, 7-25
Tax policy, 5-51
Telemetering, 5-91
Temperature control, 6-16
  magnetic tape recording, 6-50
Testing,
  brazed conductors, problem, 5-142; 8-127
  electrical, 4-20; 7-28
  electronic equipment, 3-61
  functional, 3-61
  inspection, 3-61; 8-16
  oil well, 8-57
  vacuum tubes, 6-19
Thermocouples, testing of, 4-139
Timing percentage, 3-159
Tool,
  drilling, 3-22
  thread top, 3-24
Torn, L.
  Applying Magnetostrictive Actuation, 4-73
Transducers, 3-14
  air to electric, 3-30
Transfer devices, 3-159; 5-19, 88; 7-41, 60, 61
Transfer machines, 7-64
  assembly operations, 4-12, 50
  numerically controlled, 6-34
Transistors, 4-148
  power, 5-10
Translation, technical publications, 3-10
Treer, K. R.
  Feeding Discrete Parts, 5-82
Trucks, industrial, 3-156
TV,
  closed circuit, problem, 7-122
  closed system planning, 7-118

V

Valves,
  control, 7-113
  electrohydraulic, 8-71
  pneumatic, 3-146
  servo, 5-14; 7-113; 8-71
Van Nice, R. I.
  Optimizing Process Operations, 5-71
Vibration, magnetic tape recording, 6-50
Vibratory feeders, 5-82

W

Warehousing, 5-68
Weber, W. C.
  Hydraulic Actuation Simplified, 3-86
Weigher-feeder scales, 7-40
Weighing, 5-76
  bulk materials, 7-34
  continuous, 5-14
  control, 3-94
  crane problem, 4-140; 7-123
  missiles, 8-62
  paper rolls, 6-49
Welding, 5-14, 74; 8-14
  production line, 6-68; 7-41
Williams, J. C., Jr.
  Automatic Weighing Techniques for Processing Bulk Materials, 7-34

X

X-ray inspection, 6-10

Y

Yomine, D. J.
  Manufacturing Team for Automation, 8-34

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AUTOMATION problem forum

Readers with problems concerning systems, equipment or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Solution suggestions should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

Case 1571-P
Cutting Coiled Wire

. . . Enclosed are samples of coiled copper-base wires (wires about 30 to 40 ga, helical type coil, OD of coil up to about 1/16 inch, coils about 36 inches long). Kindly advise us of any machines which could feed, measure, and cut off ¼-inch lengths. . .

Processor

◆ ◆ ◆

Case 1544-P
Sensing Heads

. . . One of our clients is at present manufacturing a measuring device equipped with a dial indicator as the sensing end with dial graduations of 0.0001 inch. It is now desired that positive accuracy of 0.00005 inch be attained. We would appreciate any suggestions concerning the type of sensing head (electronic, airgap, magnetic, optical, or mechanical) which might seem appropriate and especially any information regarding suppliers of such equipment. . .

Chief Designer

◆ ◆ ◆

Case 1593-P
Cutoff and Chamfer

. . . Please advise as to availability of a machine to cut off and chamfer ¼-hard copper tubing in ¼, 5/16, and ⅜-inch diameters, in 3 to 12-inch lengths. Will appreciate any help. . .

Engineer

◆ ◆ ◆

Suggestions for 1505-P (May 1958)
Press Feeding

. . . We would be interested in working with your reader on the above case number. We require general press information and a drawing of the die to be loaded in order to make our recommendation and furnish a quotation. . .

F. J. Sehn
Press Automation Systems Inc.

. . . We are very much interested in working on automation feeding problems with these people. . .

H. R. Blackburn
Die & Automation Inc.

◆ ◆ ◆

Suggestions for 1496-P (May 1958)
Testing Brazed Conductors

. . . We believe that this detection may be accomplished by an accurate measurement of the joint resistance utilizing our Model 151-S Microhm Meter. We are sending you two bulletins on this instrument and would appreciate your passing one along to your reader. . .

E. Van Ressel
J. W. Dice Co.

◆

. . . One of our Field Engineers will be glad to contact your reader to determine whether any of our nondestructive testing methods would be applicable. . .

H. E. Coonrod
Magnaflux Corp.

◆

. . . It appears possible that a fluorescent penetrant technique might serve to detect defective connections. We shall be pleased to study detailed information and send our recommendations. . .

Charles Weeks
Menlo Research Laboratory

◆

. . . We are enclosing a bulletin describing the Surface Resistance Indicator which we manufacture. We are in a position to provide a fixture which could be placed across the suspected joint allowing a Microhmmeter reading to be taken of the resistance of this joint. . .

E. I. Matthews
Sunshine Scientific Instrument

◆ ◆ ◆

Suggestions for 1493-P (June 1958)
Sorting Mixed Parts

. . . We would like to know the name and address of this firm. With scale requirements of this nature additional information would be required before we would be in a position to submit any definite recommendations to them. . .

F. R. Cochrane
Exact Weight Scale Co.

◆

. . . The problem of segregating irregularly shaped parts is definitely in line with our work and experience, and we would be interested in knowing more about it. If your reader will send us representative samples, we will be pleased to co-operate with him. . .

J. R. Stoddard
Barkley & Dexter Inc.

Advertising Index

Adel Precision Products, A Division of General Metals Corporation 20
Allis, Louis, Co. 77
Alvey Conveyor Manufacturing Co. 8
American Can Co. 2
American Chain & Cable, Automotive Aircraft Division 121
Apex Machine & Tool Co., The 111
Automation Devices, Inc., Peeco Division 105
Automotive & Aircraft Division, American Chain & Cable 121

Baldor Electric Co. 99
Bellows Co., The, Division of International Basic Economy Corporation 27
Bell Telephone Laboratories 78
Bin-Dicator Co., The 122
Bliss, E. W., Co. 13
Buschman, E. W., Co., The 93

Campbell Machines Co. 114
Cleveland Tramrail Division, The Cleveland Crane & Engineering Co. 21
Clippard Instrument Laboratory, Inc. 122
Control Division, Magnetics, Inc. 81
Curtis Development & Mfg. Co. 118

Detroit Power Screwdriver Co. 108
DeVilbiss Co., The 85
Dixon Automatic Tool, Inc. 23

Edison, Thomas A., Industries, Instrument Division 11
Eriez Manufacturing Co. 101

Fairbanks, Morse & Co. 32
Falk Corporation, The 17
Farval Corporation, The 19
Feedmatic-Detroit, Inc. 120
Ferguson, J. L., Co. 29
Flick-Reedy Corporation, Miller Fluid Power Division 5

General Dynamics Corporation, Stromberg-Carlson Division 106
General Metals Corporation, Adel Precision Products Division 20
Greenlee Brothers & Co. 94

Hannifin Co., A Division of Parker-Hannifin Corporation 1
House Machines, Inc. 114
Horsburgh & Scott Co., The 104

International Basic Economy Corporation, The Bellows Co. Division 27

Kearney & Trecker Corporation 86, 87

Lansing Stamping Co. 123
Le Marie Machine Tool Co. .... Back Cover

McGill Manufacturing Co., Inc. 15
McKay Machine Co., The .... Inside Back Cover

Magnetics, Inc., Control Division 81
Micro Switch, A Division of Minneapolis-Honeywell Regulator Co. 128
Miller Fluid Power Division of Flick-Reedy Corporation 5
Minneapolis-Honeywell Regulator Co., Micro Switch Division 128
Moline Tool Co. 110

National Acme Co., The 89
National Electric Welding Machines Co. 83

Parker-Hannifin Corporation, Hannifin Co. Division 1
Peeco Division, Automation Devices, Inc. 105
Peerless Electric Co., The 116
Pneu-trol Devices, Inc. 119
Potter & Brumfield, Inc. 109

Reeves Pulley Co., Division of Reliance Electric & Engineering Co. 103
Reliance Electric & Engineering Co., Reeves Pulley Co. Division 103

Sciaky Bros., Inc. 24
Snyder Tool & Engineering Co. .... Inside Front Cover
Special Engineering Service, Inc. 123
Sperry Rand Corporation, Vickers, Inc. Division 113
Standard Instrument Corporation 120
Standard Tool & Manufacturing Co. 107
Stromberg-Carlson A Division of General Dynamics Corporation 106

Thomas Truck & Caster Co. 31
Tomkins-Johnson Co., The 97
True-Trace Sales Corporation 92

United States Drill Head Co. 84

Vickers, Inc., Division of Sperry Rand Corporation 113

WLS Stamping Co. 118
Warrick, Charles F., Co. 114
Westinghouse Electric Corporation 6, 7, 90, 91
West Instrument Corporation 30

Yoder Co., The 22

Consulting Engineer's Service 126

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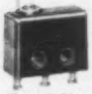

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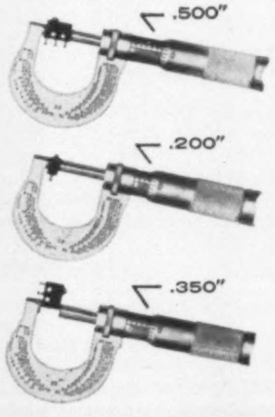

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Circle 711 on Page 131

new catalogs..... latest literature

Relays & Switches

Automatic Electric Sales Corp., Northlake, Ill.—102 *page catalog*—Data on complete line of industrial relays and rotary stepping switches are given. Large section is devoted to relay reference data, which includes notes on relay timing, coil construction, and types of spring insulation. Photos show the different relay mountings. Numerous tables list relay characteristics, and special features of relays and switches.

Circle 479 on Page 131

Tangent Bending Machines

Taylor-Winfield Corp., Warren, Ohio—8 *page bulletin*—Line of air-operated tangent bending machines designed for light-duty metal forming is outlined in Bulletin 13-093. Many uses, such as in the manufacture of electrical switch cases, control and capacitor boxes, and air conditioning units, are noted. Also described and illustrated are package units consisting of a variety of equipment which provide automation of fabrication lines involving forming.

Circle 480 on Page 131

Hydraulic Cylinders

Miller Fluid Power Div., Flick-Reedy Corp., 2040 N. Hawthorne Ave., Melrose Park, Ill.—32 *page catalog*—Uses of hydraulic cylinders are outlined in Bulletin JH-104N. It contains data on cylinder models for 500-2500 psi service, and models for 3000-5000 psi service. Charts list column strength, piston rod deflections, acceleration, cylinder forces, pressure losses in pipes, etc. Also described are air-oil devices, flange-fitted ports, and cylinder accessories.

Circle 481 on Page 131

Overhead Conveyors

Conveyor Div., American MonoRail Co., Fourth & Franklin Streets, Tipp City, Ohio—44 *page catalog*—Data on various types of overhead conveyors are given in Catalog CDA. Construction of the drive, cable, trolleys, and carriers and guards is explained. A diagrammatic plan for calculating an overhead conveyor system is given, and the steps involved in installation are described. Charts list standard vertical bends and vertical dips. Ten pages of photos show various applications.

Circle 482 on Page 131

Glass Temperature Control

Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.—4 *page pamphlet*—A control system, suitable for glass container manufacturers, is described. Functions of the system are discussed, and photos help explain the different operations. All the equipment is listed that is required for electric and electropneumatic control of a glass feeder.

Circle 483 on Page 131

Office Layout Materials

Labelon Tape Co. Inc., Rochester 9, N. Y.—12 *page booklet*—Tapes and materials for creating a layout of an office are described and illustrated. The steps involved from the rough draft to the completed plan are given. Line of accessory pressure sensitive symbols with prices is also noted.

Circle 484 on Page 131

Data Processor

Business Automation Equipment Div., Taller & Cooper Inc., 75 Front St., Brooklyn 1, N. Y.—9 *page bulletin*—Desk-top machine, which can be used in data processing installations, is described. Unit accepts fixed data from tabulating or edge-punched cards and variable data through its digital keyboard, combines the information, and punches it out on tape. Specifications and features are listed and various business and industrial applications are given.

Circle 485 on Page 131

Shaft-Mounted Speed Reducers

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.—10 *page bulletin*—Data on horsepower ratings, dimensions, installation, and maintenance for shaft-mounted speed reducing units are contained in Bulletin B-7238. Construction features for both single and double reduction units are given. Also included are notes on how to select a reducer.

Circle 486 on Page 131

Palletizing System

Lathrop-Paulson Co., 2459 W. 48th St., Chicago 32, Ill.—4 *page pamphlet*—Palletizing system, which consists of a stacker, a pusher, and a conveyor, is outlined. The system is suitable for cases and cartons, or for pails or cans. Illustrations show the various steps in the operation.

Circle 487 on Page 131

Adjustable Speed Drives

Cutler-Hammer Inc., 315 N. 12th St., Milwaukee 1, Wis.—12 *page booklet*—Magnetic amplifier packaged drive, designated Ultraflex M, is the subject of Bulletin EN-65. The drive, which consists of a panel containing the conversion and control devices, a dc motor, and an operator's station, is described. The protective system is explained, and sketches show the different styles of motors available.

Circle 488 on Page 131

Feeding Systems Nomograph

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.—3 *page pamphlet*—Nomograph is suitable for sizing controlled volume pumps and tanks for chemical feed systems. Charts are set up so that the correct sizes can be calculated in a few seconds. Examples are given to help explain the method.

Circle 489 on Page 131

Thermistors & Varistors

Victory Engineering Corp., 505 Springfield Rd., Union, N. J.—10-*page bulletin*—Engineering data covering more than 250 stock thermistors and varistors are given. Applications and characteristics are listed, and curves and drawings are shown to help in the selection of the proper unit. Also included are definitions of terms commonly used in the application of thermistors and varistors.

Circle 490 on Page 131

Magnetic & Motorized Valves

Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.—24 *page catalog*—Magnetic and motorized valves for use with air, water, gas, steam, and oil are described in Catalog V-58. Two flow charts, one for liquids, and one for compressible fluids, are included, as are dimension drawings and solenoid coil rating tables.

Circle 491 on Page 131

Tracer Control

Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—12 *page booklet*—Vertical profiler, which provides spark gap tracer control for completely automatic 360 degree profile milling operations, is described. Operating principle and machine construction are explained and specifications listed. Illustrations display the control in various stages of operation.

Circle 492 on Page 131

Government Specifications

Adhesives, Coatings, & Sealers Div., Minnesota Mining & Mfg. Co., 423 Pi-

new catalogs..... latest literature

quette Ave., Detroit 2, Mich.—23 page report—U. S. Government specifications for a wide variety of adhesives, coatings, and sealers are given in booklet. Listed in numerical form are military, army, and federal specifications, their definitions, and the corresponding 3M adhesive, coating, or sealer.

Circle 493 on Page 131

Bin Level Indicators

Bin-Dicator Co., 13946-209 Kercheval Ave., Detroit 15, Mich.—20 page booklet—Three types of automatic bin level indicators are described—the Bin-Dicator, a diaphragm type bin level indicator; the Roto-Bin-Dicator, a rotating paddle type bin level indicator; and the Bin-Flo Aerator, a unit which promotes the flow of dry, finely ground bulk materials. Included in the booklet are cutaway and schematic drawings, outline dimensions, general specifications, and suggested systems.

Circle 494 on Page 131

Layout Tracers

Crown Products Div., Hannifin Co., 542 S. Wolf Rd., Des Plaines, Ill.—Drafting aids—Package contains 8 loose-leaf cards on which are printed outlines of various units, such as filters, regulators, lubricators, and accessories. They are scaled 1/8-inch to 1-inch, 1/4-inch to 1-inch, and 1/2-inch to 1-inch, and provide an easy way of tracing the units on plans. Design suggestions are also given.

Circle 495 on Page 131

Fluid Cylinders

Pathon Mfg. Co., Cincinnati 12, Ohio—36 page catalog—Line of air and low pressure hydraulic cylinders is described and their application given in Bulletin 25. Construction features are explained and data on installation and operation are given. Also listed are parts and ordering instructions.

Circle 496 on Page 141

Hydraulic Multipress

Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio—8 page bulletin—One ton multipress which is suitable for assembling, riveting, punching, marking, straightening, and broaching, is described in Bulletin 310-A. Examples on how the press can be applied to automatic, semiautomatic, and manual production operations are included. Illustrations show the various advantages.

Circle 497 on Page 131

Instrumentation Systems

Fischer & Porter Co., 550 Jacksonville Rd., Hatboro, Pa.—12 page booklet—Instrumentation systems for the cane sugar industry are described in Catalog 90-260-10. Juice heater temperature control, flow measurement, and totalization are explained. Schematic drawings show the automatic liming system, the evaporator instrumentation system, and the temperature compensated type Brix measurement system.

Circle 498 on Page 131

Thermistor Basic Reference

Fenwal Electronics Inc., Mellen Street, Framingham, Mass.—16 page booklet—More than 400 different thermistors are described in Catalog EMC-2, including assemblies, matched pairs, heads, discs, washers, rods, and probes. Basic thermistor properties and characteristics, and how the units can be used for circuit design are expained. Diagrams show typical ap-

Circle 499 on Page 131

Assembly Machines

Electrical Contacts Div., Judson L. Thomson Mfg. Co., Waltham 54, Mass.—4 page pamphlet—Automatic electrical contact setting machines for setting single contacts, multicontacts, and double-headed contacts are described. Illustrations show special work handling devices which are available.

Circle 500 on Page 131

Industrial Blowers & Exhausters

Miehle-Dexter Div., Subsidiary, Miehle-Goss-Dexter Inc., 100 Fourth St., Racine, Wis.—6 page pamphlet—Data are given in Bulletin 581, on line of rotary positive industrial blowers and exhausters with pressure ratings ranging up to a maximum of 14 psig in single-stage and to 70 psig in multistage operation. Operating information, specifications, and performance curves are noted. Illustrative examples of various applications are also included.

Circle 501 on Page 131

Data System

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—8 page bulletin—Bulletin E 72-1 describes system which gathers data, converts it, and displays it in digital or numerical form. Components in the unit, which is designated Metrotype, are discussed and illustrated. Operation and control functions are explained. Also included is a schematic drawing which shows a typical setup of the system.

Circle 502 on Page 131

Slitting Equipment

Yoder Co., 5500 Walworth Ave., Cleveland 2, Ohio—76 page handbook—Data on coil and sheet equipment, such as slitters, uncoilers, recoilers, coil cars, and scrap choppers, are given. Also included is a discussion of coil handling and scrap disposal methods. Notes on the selection and operation of slitters and slitting lines, including time studies and analysis of operating cycle are given.

Circle 503 on Page 131

Automatic Drum Filler

Rucker Co., 4700 San Pablo Ave., Oakland 8, Calif.—4 page pamphlet—Filler, which is designed to accommodate all types of 55-gallon drums, is described. Illustrations show the operational details of the machine. Safety features, design, and advantages of the automatic unit are explained.

Circle 504 on Page 131

Precision Index Tables

Ferguson Machine Corp. of Indiana, 7818 Maplewood Industrial Court, St. Louis 17, Mo.—16 page booklet—Intermittor index tables and rotary transfer machines for high speed, precision assembly and manufacturing, are outlined in Catalog 302. Numerous index tables list load ratings, dimensions, and indexing periods. Illustrations show typical applications.

Circle 505 on Page 131

Motor Speed Control

Fidelity Instrument Corp., 1000 E. Boundary Ave., York, Pa.—4 page pamphlet—Motor controls are described in Bulletin 558-1. The control makes use of static magnetic amplification to maintain the desired motor speed regardless of load variation. Other company products are also listed.

Circle 506 on Page 131

Belt Conveyors

E. W. Buschman Co., Cincinnati 32, Ohio—4 page pamphlet—Data on horizontal and inclined belt conveyors are given in Catalog 80. Specifications are listed for the combination drive and take-up, end idler assembly, intermediate section, belt, and power feeder section. Schematic drawings show layouts for both inclined and horizontal conveyors.

Circle 507 on Page 131

Modular Enclosure System

Elgin Metalformers Corp., Elgin, Ill.—36 page catalog—Data are given in Catalog 105 on modular enclosure systems which can be used wherever an application requires a cabinet, console, or a series of cabinets. Illustrations show the basic frames and the arrangements that can be made. Component parts are listed and ordering instructions given.

Circle 508 on Page 131

Miniature Electrical Connectors

Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.—29 page report—Com-

plete series of laboratory tests for electrical, environmental, and physical characteristics of the connectors is reported. Factors investigated and reported on include: Connector engaging and separating forces, temperature cycling, vibration, durability, and effect of high altitude with heat. The methods of all the tests are explained and results stated.

Circle 509 on Page 131

Pneumatic Products

Industrial Div., Watts Regulator Co., Lawrence, Mass.—20 page booklet—Air line filters, regulators, and lubricators are outlined in Catalog 616. Features of the three products are explained and engineering and operational data, such as performance characteristics and specifications, are given. Also covered are filter, regulator, and lubricator combinations.

Circle 510 on Page 131

Woodworking Machines

Union Tool Corp., Warsaw, Ind.—6 page pamphlet—Woodworking machines, for panel-to-frame gluing and edge gluing, are outlined in Bulletin HF-256. Four different models are described and their advantages, operation, and features explained. Specifications for each model are also listed.

Circle 511 on Page 131

Quick Disconnect Couplings

Snap-Tite Inc., Union City, Pa.—25 page catalog—Line of quick-connect, quick-disconnect couplings is described. Included in the line are couplings for high pressure applications, for impact in air lines, for low pressure applications, for vacuum and very low pressures, and for hard to handle fluids. Temperature ranges are listed, and graphs and tables show flow and pressure drop. Also noted are spare parts and accessories.

Circle 512 on Page 131

Photoelectric Cells

Electric Products Div., Vickers Inc., 1815 *Locust St., St. Louis* 3, *Mo.—12 page booklet*—Self-generating photoelectric cells, which can be applied in various manufacturing and process industries, are described in Bulletin EPD 3216-1. Charts showing power output ranges, and electrical circuit diagrams showing different applications are included. Construction details and performance characteristics are noted.

Circle 513 on Page 131

Automatic Grinder Controls

Radio Corp. of America, Bldg. 15-1, *Camden, N. J.—4 page pamphlet*—Automatic grinder controls for ID, OD, and surface grinding, are outlined in Form 3R3342. Advantages and operation of the system are noted. The systems available range from simple machine shut-off or alarm, to size indication and segregation,

INDEX OF EQUIPMENT BY ITEM NUMBERS

(New Equipment, New Components, and New Literature covered in this issue)

Actuator, rotary, 456
Agitator drive, 435
Alarm, gas, 441
Assembly
  machines, 500
  tips to leads, 418

Ball bearings, 472
Base, circuit, 464
Bending machines, 480
Bearing, sliding ball, 472
Blowers, industrial, 501
Boring machine, 416
Bridge, capacitance, 417

Capacitance bridge, 417
Case loader, 415
Cells, photoelectric, 513
Chassis, indexing, 424
Chlorinator, pneumatic, 451
Circuit base, 464
Clamps, 434
  paper roll, 413
Cleaning, ultrasonic, 422
Clutch, 454
Coated abrasive head, 429
Coatings, 493
Connectors
  electrical, 509
  miniature, 528
Contact assembler, 500
Controls, 521
  chlorinator, 451
  detector, 462
  grinder, 514
  instrumentation, 531
  liquid level, 432
  motor speed, 506
  regulator, 433
  temperature, 440, 452, 483
Conveyors
  belt, 507
  overhead, 482
  roller, 517
  telescoping, 414
  trolley, 409
Counter, timer, 461
Couplings, 512, 522
Cylinders
  fluid, 496
  hydraulic, 439, 455, 481, 525

Data processing
  transceiver, 445
Data processors, 411, 485
Data system, 502
Detector, for sheets, 462
Differential
  transformer, 474
Discriminator, 459
Drives
  agitator, 435
  speed reducers, 486
  variable speed, 428, 488
Drum filler, 504

Ejecting, 408
Electrical components, 430, 444, 447, 454, 457, 458, 468, 470, 476, 479, 490, 509, 513, 520, 523, 528, 529, 530
Epoxy glass base, 464
Exhausters, industrial, 501
Fan.cooling, 467

Feed valve, 431
Feeders, 404
  vibrating, 410
Feeding systems, 515
  nomograph, 489
Filler, pressure, 405
Filters, 463
  airline, 510
Finishing
  coated abrasive head, 429
  spray booth, 425
Flame heating machine, 402
Flow meters, 526
Flow rate transmitter, 427
Flow regulator, 433
Forging machine, 407

Gage, sheet thickness, 462
Gas alarm, 441
Glass temperature control, 483
Grinder controls, 514

Handling, 408
  case loader, 415
  conveyors, 409, 414, 482, 507, 517
  feeders, 404, 410
  feeding systems, 515
  hopper, 403
  indicators, 494
  loader, 404
  paper roll clamp, 413
  plate, 419
  tractor shovel, 516
Heating machine, 402
Hopper, 403
Hydraulic components, 433, 437, 439, 446, 450, 455, 463, 481, 496, 525
Hydraulic press, 497

Indexing
  chassis, 424
  tables, 505
  tapper, 421
Indicators, 432, 494
Inspecting, 408
Instrument controls, 430, 447, 457, 461, 465, 466, 518, 524
Instrument indicators, 427, 453, 526
Instrumentation, 531
  recorders, 518
  systems, 498

Layout materials, 484
Layout tracers, 495
Level controls, 432, 494
Loaders, 404
  case, 415
Lubrication components, 431
Lubricators, 449
  airline, 510
  fog, 436

Machine tools
  bending, 480
  borer, 416
  forging, 407
  hydraulic press, 497
  milling, 406
  press, 412
  profiler, 492
  punch shaper, 426
  slitters, 503
  transfer machines, 401, 505
  wire stripper, 423
Machine tool attachments
  grinder controls, 514
Machines
  assembly, 500
  flame heating, 402
  index tables, 505
  nailing, 519
  tipping, 418
  welding, 527
  woodworking, 511
Magnetic clutch, 454
Magnetic valves, 491
Manifold, valve, 460
Measuring
  flowmeters, 526
  instrumentation, 498
  moisture, 466
  temperature, 452, 524
  temperature control, 440, 483
  transducer, 474
  transmitter, 427
Meter-relay, 447
Meters, flow, 526
Microwave
  components, 523
  tubes, 523
Milling machine, 406
Modular enclosure system, 508
Modulator, pulse, 442
Monitor, moisture, 466
Motion indicator, 430
Motor speed control, 506
Motorized valves, 491
Motors
  dc, 458
  fluid, 530
  industrial, 470
Nailing machines, 519
Nomograph, for feeding systems, 489
Nut, self retaining, 475

Packaging, 408
  drum filler, 504
  filler, 405
  palletizing system, 487
  strapper, 420
Palletizing system, 487
Paper roll clamp, 413
Photoelectric cells, 513
Planning
  layout materials, 484
Plate handler, 419
Pneumatic components, 434, 438, 456, 460, 471, 491, 496, 510
Presses
  bench, 412
  hydraulic, 497
Pressure filler, 405
Processing valve, 443
Profiler, vertical, 492
Proportioning, chlorine, 451
Pulse modulator, 442
Pumps, 530
  diaphragm, 438
  hydraulic, 450
Punch shaper, 426

Raceway, 448
Radial ball bearings, 472
Readout, 453
Recorders
  electronic, 465
  instrumentation, 518
Reducers, speed, 486
Regulators
  air, 510
  flow, 433
Relays, 479
Relay, meter, 447
Rotary actuator, 456

Sealers, 493
Shaper, punch, 426
Shipping case loader, 415
Shovel, tractor, 516
Slitting equipment, 503
Solenoid, miniature, 476
Specifications, for coatings & sealers, 493
Speed control, for motors, 506
Speed reducers, 486
Spray booth, 425
Starter conversion kit, 468
Strapper, steel, 420
Stripper, wire, 423
Supervisory control equipment, 521
Switch controller, 457
Switches
  foot, 444
  rotary stepping, 479
  transfer, 520

Tape controlled milling machine, 406
Temperature controls, 440, 452, 483, 524
Testing, capacitance bridge, 417
Thermistors, 490
  reference, 499
Thermocouple assemblies, 524
Timer, 461
Tipping machine, 418
Totalizer, readout, 453
Tracer control, 492
Tracers, layout, 495
Tractor shovel, 516
Transceiver, telemetering, 445
Transfer machines, 401, 424, 505
Transformers, 529
Transmitter, flow rate, 427
Tube fitting, 469
Tubes
  microwave, 523
  modulator, 442

Upset forging machine, 407

Valves, 437, 491, 530
  ball, 446
  capping, 443
  feed, 431
  manifold, 460
  poppet, 471
Variable speed drives, 428,
Varistors, 490

Welding machines, 527
Wire stripper, 423
Woodworking machines, 511 488

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Page No. **Title of Article**

....

....

....

401	441	481	521	561	601	641	681	721	761	801
402	442	482	522	562	602	642	682	722	762	802
403	443	483	523	563	603	643	683	723	763	803
404	444	484	524	564	604	644	684	724	764	804
405	445	485	525	565	605	645	685	725	765	805
406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
427	467	507	547	587	627	667	707	747	787	827
428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
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432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
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437	477	517	557	597	637	677	717	757	797	837
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Circle 514 on Page 131

Feeding Systems

Omega Machine Co., Div., B-I-F Industries Inc., 345 Harris Ave., Providence 1, R. I.—8 page bulletin—Simplex or duplex gravimetric feeders for liquids or solids are the subject of Bulletin 32-R2. Continuous loss-in-weight feeding systems are explained. This type of system maintains accuracy within ½ per cent of set feed rate over the entire range. Also included are dimensional drawings, schematic drawings, and performance charts.

Circle 515 on Page 131

Industrial Tractor Shovel

Materials Handling Div., Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.—20 page booklet—Information is given in Bulletin 5255 on Model Y-18, industrial tractor shovel, which has 2500 lb carrying capacity and 12-27 cu ft capacity. Features of the machine are explained and illustrative examples of maintenance methods included.

Circle 516 on Page 131

Roller Conveyors

Logan Co., 200 Cabel St., Louisville 6, Ky.—8 page bulletin—Three lines of stock roller conveyors are outlined in Bulletin 80. The first features a device for setting rollers high or low; the second is produced in aluminum and lightweight steel, and the third has a multiple punched frame for variation of length and spacing of rolls. Specifications are listed, and sketches show the method of construction.

Circle 517 on Page 131

Instrumentation Recorders

Instrumentation Div., Ampex Corp., 934 Charter St., Redwood City, Calif.—16 page booklet—Model FR-100A, a modular magnetic tape recorder/reproducer for instrumentation, is described. Numerous applications of the recorder are noted. Features, such as six tape speeds, and four types of recording, are explained. Data on the tape transport are given and photos show the arrangement of component parts.

Circle 518 on Page 131

Nailing Machinery

Packing Equipment Div., Food Machinery & Chemical Corp., Riverside, Calif.—8 page bulletin—Data on line of nailing equipment are given. The theory and operation of heavy duty and standard types of nailers are explained. Features, such as hydraulic drive, electric nail selection, monitored nail feed, and custom jigs and tables, are described.

Circle 519 on Page 131

Automatic Transfer Switches

Automatic Switch Co., Florham Park, N. J.—24 page handbook—Data on the application and selection of automatic transfer switches are given in Bulletin 596R1. Requirements such as inrush capacity, continuous duty rating, rapid transferal of load, double source control, and full phase protection are discussed.

Circle 520 on Page 131

Supervisory Control Equipment

General Electric Co., Schenectady 5, N. Y.—20 page booklet—Equipment, which is used in master and remote stations to control ac switching operations, hydro generating equipment, and pumping equipment is described in Bulletin GET-2738. Ratings, dimensions, and line connections are given. An elementary diagram which shows the principle of operation of the system is included.

Circle 521 on Page 131

Flexible Couplings

Ajax Flexible Coupling Co. Inc., Westfield, N. Y.—24 page catalog—Data are given in Catalog 55-B on flexible couplings which cushion vibration, require no lubrication, operate horizontally or vertically, and provide free end float. Construction of the different models is explained. Illustrative examples of various applications are included.

Circle 522 on Page 131

Microwave Tubes & Components

Bomac Laboratories Inc., Salem Road, Beverly, Mass.—6 page pamphlet—Specifications are listed on TR, ATR, PreTR, and attenuator tubes, dual and triple TR and ATR tubes. Also included are pressurizing windows, spark gap tubes, surge protectors, silicon diodes, magnetrons, reference cavities, shutter tubes, klystrons, and traveling wave amplifier tubes.

Circle 523 on Page 131

Thermocouple Assemblies

Thermo Electric Co. Inc., Saddle Brook, N. J.—12 page booklet—Data on heavy duty industrial thermocouple assemblies are contained in booklet, designated Section E. Six different thermocouple connection heads and six basic types of thermocouples in all standard gages and calibrations are described.

Circle 524 on Page 131

Hydraulic Cylinders

Petch Mfg. Co., 463 York St., Detroit 2, Mich.—6 page pamphlet—Air and low pressure hydraulic cylinders in eleven standard mounting types, with bore sizes from 1½ to 6 inches, are covered in Bulletin PMC 58. Drawings explain such features as the power saver gland, power positive cushion, and power preserver seal.

Circle 525 on Page 131

Indicating Flowmeters

Seico Instrument Div., Eclipse Fuel Engineering Co., Rockford, Ill.—7 page pamphlet—Data are given on line of indicating flowmeters designed for use with air, gas, and liquids. Bulletin V-100 contains ranges, scales, pressures, and mechanical details. The movable vane principle used in the meters, and the three systems of indication used in the various mediums being measured, are explained. Mounting arrangements are also shown.

Circle 526 on Page 131

Welding Machinery

Arco Welder Mfg. Co., 1719 W. St. Paul Ave., Milwaukee 3, Wis.— 12 page booklet—Line of special resistance welders, special arc welders, and standard resistance welders is described and illustrated in Bulletin 156. Included in the line are single and multihead automatic and semiautomatic welders employing work loading, indexing, and ejecting equipment. Company's services and facilities are also described.

Circle 527 on Page 131

Miniature Connectors

Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.—40 page catalog—Specifications, drawings, and general data on line of miniature connectors are given. This line includes devices such as guide pins, guide sockets, protective shells, various plugs, and coaxial contacts. The molding compounds are explained and ordering instructions given.

Circle 528 on Page 131

Transformers

Freed Transformer Co. Inc., 1705 Weirfield St., Brooklyn 27, N. Y.—48 page catalog—Among units described in Catalog 581 are audio transformers, discriminators, filter, high Q reactors, magnetic amplifiers, power components, pulse transformers, and ultrasonic components. Military and commercial applications are given. Numerous performance graphs illustrate the complete line of toroid inductors.

Circle 529 on Page 131

Pumps, Motors, Valves

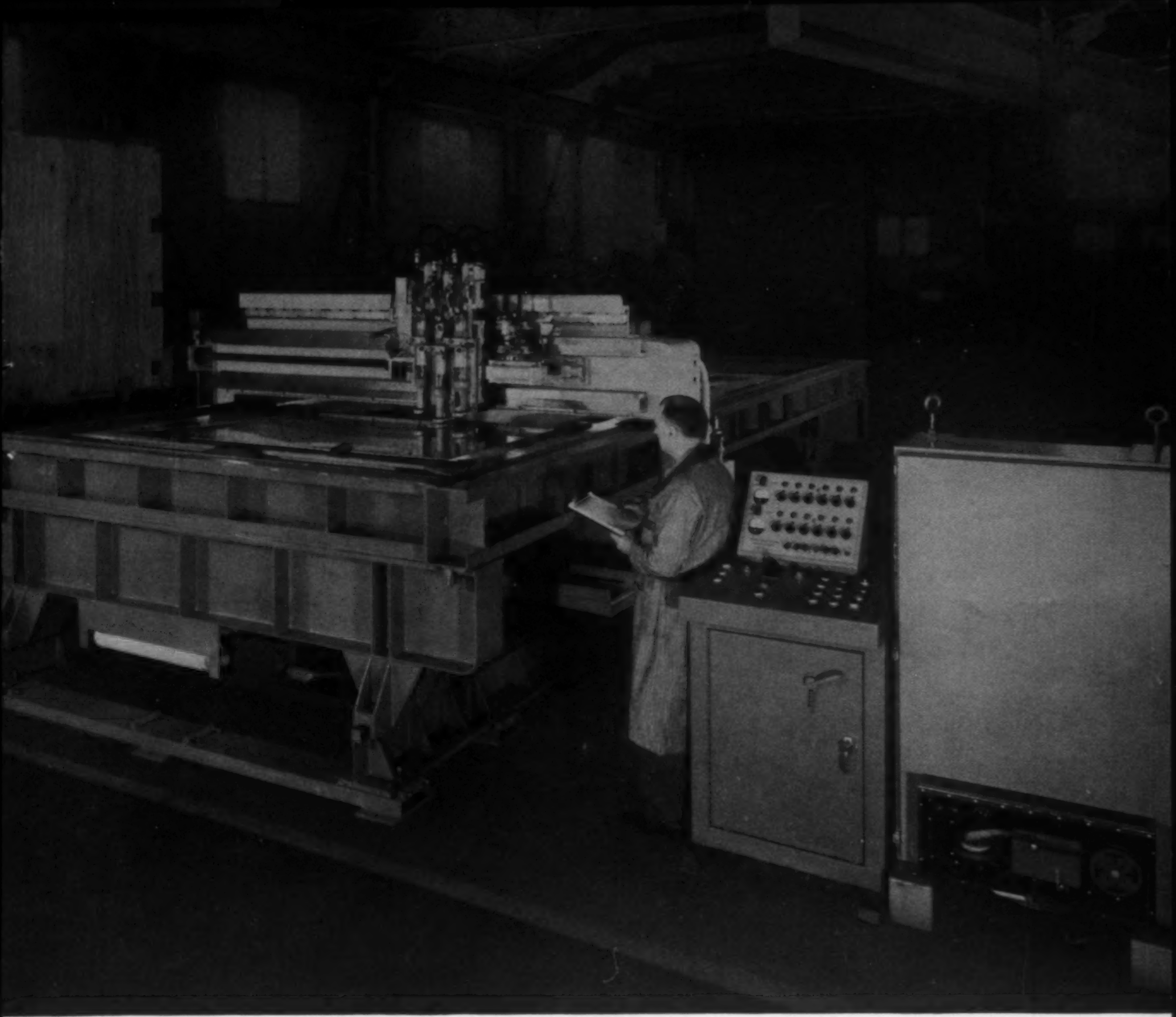
Tuthill Pump Co., 939 E. 95th St., Chicago 19, Ill.—12 page booklet—Data on line of pumps, fluid motors, and valves are given in Catalog 100. Among the units described are internal gear pumps, sliding vane pumps, and spur external gear pumps. Selection charts are listed, which classify all models as to operating requirements, mountings, and packing characteristics.

Circle 530 on Page 131

Instrumentation Control System

Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio—54 page handbook—Equipment used in Autronic Control System, which is an all-electronic control system for process and power instrumentation, is described. Principle of the electronic transmission and control is discussed. The operation is explained, aided by schematic diagrams. Other subjects mentioned are maintenance, installation, and adjustments.

Circle 531 on Page 131



Largest Automatic Precision Drill Locates, Drills and Counterbores Holes at Record Speeds

TAPE CONTROLLED MACHINE HAS AN ACCURACY OF .005" IN FULL 108" X 200" TRAVEL

Designed for aircraft work, the McKaymatic is a two dimension positioning and drilling machine that mounts three drill units on a gantry type carriage, permitting a selection of hole sizes or counterbores in a fixed work piece 9′ x 16′.

Hole locations are programmed by an engineer. This data is converted into a binary code on an 8 channel 1" wide paper tape. A tape reader and decoder relays the command information through a numerical, 2 dimension positioning control to servo drives in each axis. "Farrand Inductosyn Scales" mounted on the machine locate the drills to within .005" in the full 108" (y) and the 200" (x) axis travel.

A "zero" offset unit incorporated in the control system permits fast set-up. Templates are eliminated . . . layout time and human errors are eliminated . . . floor space requirements are kept to an absolute minimum.

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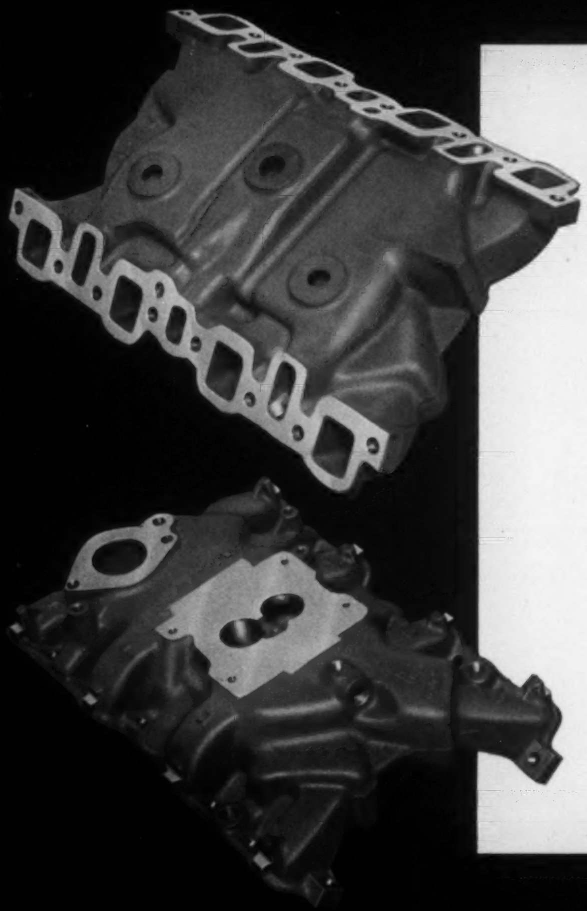
It's problem solving of this type that has made McKay an outstanding name in the aircraft, automotive, fabricating and steel industries. *The McKay Machine Company, Youngstown, Ohio.*

McKAY McK MACHINE

Circle 652 on Page 131



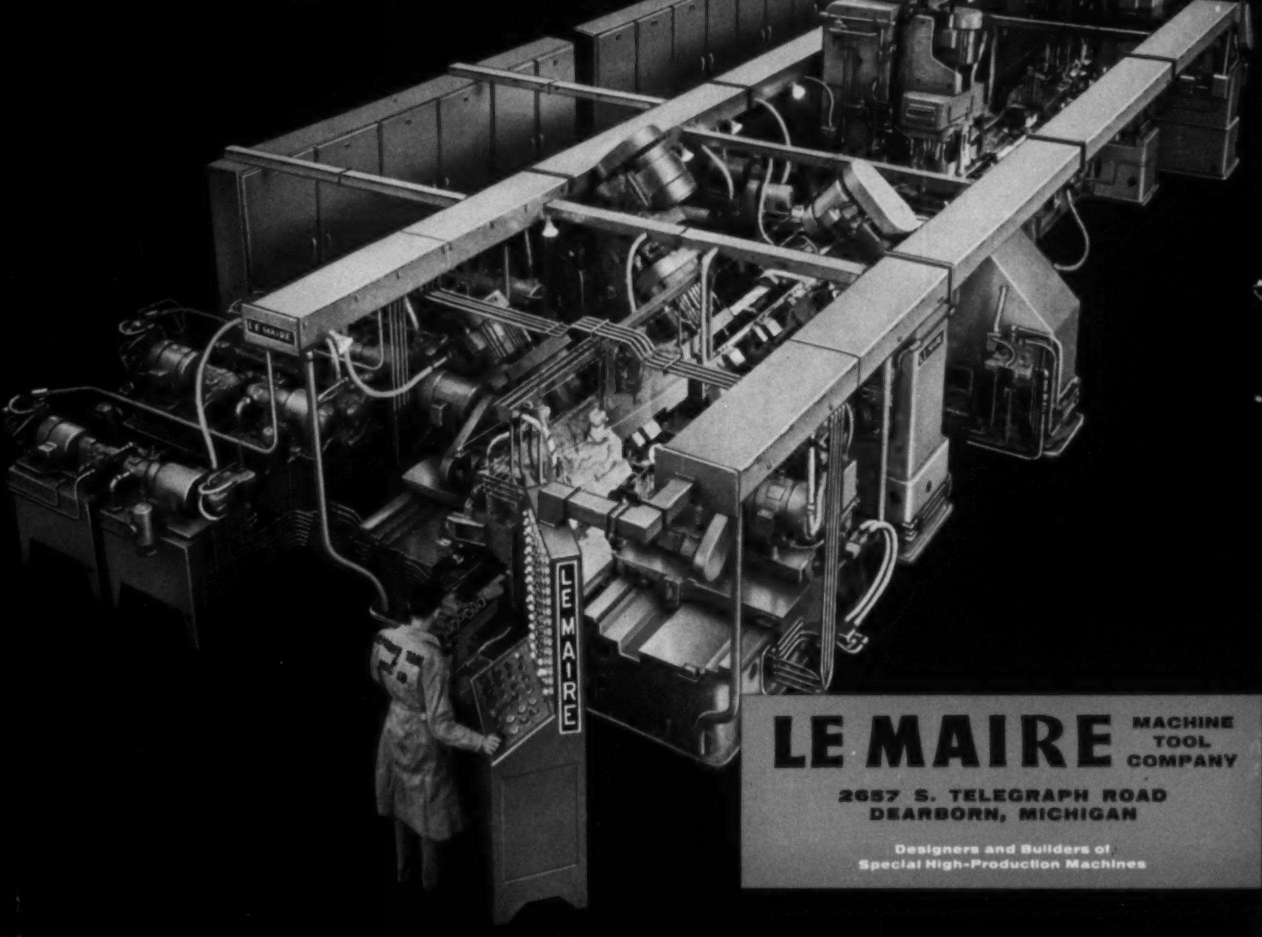
Truck Manifolds Completely Machined, Re-positioned 5 Times, in 55 Seconds

This 25-station LeMaire "Producer" completely machines three different styles of truck engine manifold castings. The machine is built for transfer-through operation and features automatic loading and clamping at each station. The part is re-positioned five times while in process during the 55-second machining cycle, including one 180 degree roll-over, one rotation for vibratory chip removal, indexing for a probing operation, one 90 degree index and re-index.

Features include: Unitized "building block" construction, with provision made for future changes—lighting at every work station—complete electrical interlock and individual selector switches and controls at each work station—"PresTest" lights on main control console—automatic selective lubrication of fixtures and ways—lights indicating "Automatic" or "Manual" control for safety during setups — electrical and hydraulic systems to J.I.C. — 189 hp electrical system—hardened and ground wear surfaces.

Here is another successful *producing* installation, designed, manufactured and tooled by LeMaire. Tell us about *your* next production machining problem.

Circle 653 on Page 131



LE MAIRE MACHINE TOOL COMPANY

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DEARBORN, MICHIGAN

Designers and Builders of
Special High-Production Machines